Agriculture Canada

FORAGE CROPS

in the Aspen Parklands of Western Canada

·PASTURING·

FORAGE CROPS
in the Aspen Parklands of Western Canada

·*PASTURING*·

Research Station Melfort, Saskatchewan

in cooperation with Saskatchewan Agriculture
and
Termuende Research Station
Department of Animal and Poultry Science
University of Saskatchewan

Research Branch
Agriculture Canada

Publication 1872/E
1991

92-01111/

© Minister of Supply and Services Canada 1991

Available in Canada through
Associated Bookstores
and other booksellers
or by mail from

Canada Communications Group—Publishing
Ottawa, Canada K1A 0S9

Cat. No. A53-1872/1991E
ISBN 0-660-14058-6

Canadian Cataloguing in Publication Data

Beacom, S. E., 1926-

Forage crops in the aspen parklands of Western Canada. Pasturing

(Publication ; 1872/E)

Author: S.E. Beacom. Cf. P. vi.
Cat. no. A53-1872/1991E
ISBN 0-660-14058-6

1. Pastures—Canada, Western. I. Canada. Agriculture Canada. Research Station (Melfort, Sask.) II. Saskatchewan. Saskatchewan Agriculture. III. Termuende Research Station. IV. Title. V. Title: Pasturing. VI. Series: Publication (Canada. Agriculture Canada). English ; 1872/E.

SB199.B4 1991 633.2'02'09712 C91-099105-7E

CONTENTS

ACKNOWLEDGMENTS vii

INTRODUCTION 1

COMPONENTS OF THE PASTURE SYSTEM 4

PASTURE - ADVANTAGES AND DISADVANTAGES 6
Advantages 6
Disadvantages 6

RATIONALE FOR PASTURE RESEARCH 7

FACTORS AFFECTING THE CHOICE OF A PASTURE SPECIES 8

FORAGE SPECIES COMMONLY GROWN FOR PASTURE IN THE ASPEN PARKBELT 9
Perennial legumes 9
Alfalfa 9
Sainfoin 9
Birdsfoot trefoil 10
Alsike clover 11
Red clover 12
Cicer milkvetch 12
Biennial legume 13
Sweet clover 14
Perennial grasses 14
Smooth bromegrass 14
Crested wheatgrass 14
Russian wildrye 15
Intermediate wheatgrass 16
Tall wheatgrass 17
Reed canarygrass 18
Meadow bromegrass 18
Other grass species 19
20

A COMPARISON OF GRASS SPECIES FOR PASTURE IN NORTHEAST SASKATCHEWAN 21

ESTABLISHING A PRODUCTIVE PASTURE 24

VARIATIONS IN PASTURE PRODUCTIVITY 25
Observations 27

METHODS FOR BALANCING PASTURE SUPPLY TO LIVESTOCK DEMAND AND FOR EXTENDING THE GRAZING SEASON 28

FERTILIZING PASTURES..... 29
Introduction..... 29
Native pasture..... 29
Grass..... 29
Legumes..... 29
Grass/legume mixtures..... 29
Annuals..... 30
Application method..... 30
Some cautions..... 30
Residual effects of applying fertilizers to pastures..... 30

FERTILIZING BROMEGRASS-ALFALFA PASTURE ON A PRODUCTIVE SILTY CLAY LOAM SOIL..... 32

RESPONSE OF BROMEGRASS-ALFALFA, RUSSIAN WILD RYE AND MIXED PASTURE STAND TO FERTILIZER APPLICATIONS ON A GRAY WOODED (WAITVILLE LOAM) SOIL AT PATHLOW..... 34
Economics..... 35

EFFECT OF ROW SPACINGS ON YIELD..... 35

GRAZING MANAGEMENT..... 36
Introduction..... 36
Livestock behavior..... 36
Plant response to grazing..... 37
Seasonal carbohydrate storage..... 37
Root growth..... 38
Grazing management systems..... 38
Relationship between stock density and beef production..... 39
Types of grazing systems..... 40
Continuous grazing..... 40
Rotational grazing..... 41
Strip grazing..... 42
Zero (mechanical grazing)..... 43
Other grazing systems..... 44
Other pasture management practices..... 44
Mineral supplementation..... 44
Growth stimulating implants..... 46
Fly control on pasture..... 46
Herd health..... 47

EFFECT OF WINTERING PLANE OF NUTRITION ON STEER GAINS ON PASTURE..... 47

GRAZING TRIALS WITH CATTLE AND SHEEP..... 51
A comparison of three pasture management systems on productive black soil at Melfort..... 51
A comparison of four systems for managing yearling beef steers on pasture..... 53
Crested wheatgrass vs Russian wild rye for pasture..... 56

ANNUAL CROPS FOR PASTURE..... 57
Production practices..... 58
Managing annual pastures..... 59
Example yields/productivity..... 59
Advantages of annual pastures..... 60
Disadvantages of annual pastures..... 60
Mechanical (zero) grazing of annual pastures..... 61

GRAZING TRIALS WITH CATTLE AND SHEEP ON ANNUAL PASTURES..... 61
Spring seeded annuals as pastures for heifers..... 61
A comparison of annual vs perennial forage crops as pasture for sheep..... 62
A comparison of oat varieties for lamb production..... 63

COW-CALF PRODUCTION ON GRAY-WOODED SOIL PASTURES (PATHLOW PROJECT)..... 64

EFFECT OF PASTURE MANAGEMENT ON THE DISTRIBUTION OF FORAGE SPECIES ON THE PATHLOW PROJECT DURING A FIFTEEN YEAR PERIOD (1975-1989)..... 70

PASTURE AND RANGE RENOVATION..... 73
Land clearing..... 73
Breaking or rebreaking..... 73
Work down..... 73
Seed drills..... 73
Time of seeding..... 74
Direct seeding (sod-seeding)..... 74
Depth of seeding..... 74
Companion crops..... 75
Economics..... 75

REJUVENATING LONG-TERM CRESTED WHEATGRASS PASTURES AT THE TERMUENDE RESEARCH STATION..... 76
Continuous..... 76
Rotational..... 76
Complementary..... 77

BRUSH CONTROL WITH WIPER-APPLICATORS..... 77

SUMMARY POINTS ON MANAGING AN EXISTING PASTURE FOR OPTIMUM PRODUCTION..... 78

WATER SUPPLY..... 80

FENCING..... 80

SUGGESTED MODEL FOR A PASTURE OPERATION ON A SECTION OF PRODUCTIVE SOIL... 82
Field layout..... 82
Features..... 82
Suggested seasonal pattern of use..... 83

A. ESTIMATED PRODUCTIVITY OF THE PASTURE ENTERPRISE USING GRAZING STEERS..... 86
Assumptions..... 86
Combined pasture & finishing enterprise..... 88

B. ESTIMATED PRODUCTIVITY RETURNS UNDER A COW-CALF ENTERPRISE..... 88
Assumptions..... 88
Costs on pasture..... 89

ACKNOWLEDGMENTS

While most of the material contained in this publication has originated from pasture research conducted at the Melfort Research Station and at the station's research site on the Pathlow Community Pasture over the period from 1954 to 1989, the author/editor has also included information from other sources to provide the reader with a more complete overview of the practices and experiences involved in producing and utilizing pastures in the Aspen Parkbelt. The following have contributed directly by providing written material or indirectly by conducting the research and reporting the results of their research primarily in the Melfort Station's annual Research Highlights.

MELFORT RESEARCH STATION

Dr. S.E. Beacom	Animal Nutritionist	1952-1989 (retired)
Mr. D.A. Cooke	Forage Agronomist	1950-1977 (deceased)
Mr. W.K. Dawley	Soils Specialist	1956-1965 (deceased)
Dr. W.F. Nuttall	Soil Fertility Specialist	1965-present
Dr. J. Waddington	Forage Agronomist (now at Swift Current Research Station)	1968-1984
Dr. S. Bittman	Forage Agronomist (now at Agassiz Research Station)	1978-1987
Dr. J.A. Robertson	Ruminant Nutritionist (now at Kamloops Research Station)	1965-1985
Dr. S.O. Thorlacius	Ruminant Nutritionist (Sheep)	1972-1980 (deceased)
Mr. D.H. McCartney	Beef Cow-Calf Management Specialist	1973-present
Dr. W. Berkenkamp	Plant Pathologist	1987-present

UNIVERSITY OF SASKATCHEWAN

Dr. R.D.H. Cohen and B.D. King	Beef Cattle and Pasture Research - Termuende Research Station, Lanigan, Sask.

PROVINCE OF SASKATCHEWAN

Mr. D.A. Fraser	Research Agrologist, Saskatchewan Rural Development

OTHERS

Information on the adaptation and role of forage species for pasture has been supplemented with material from the "Alberta Forage Manual" (a joint publication of Alberta Agriculture and Agriculture Canada, Agdex 120/20-4). Information on weather has been provided by the Brandon and Lacombe Research Stations of Agriculture Canada; and on the distribution of soil types within

the prairie provinces by the Department of Soil Science, University of Saskatchewan, and University of Alberta and the Canada-Manitoba Soil Survey, University of Manitoba.

Much of the pasture research at the Melfort Station since 1974 was made possible by a cooperative arrangement with the Saskatchewan Horned Cattle Fund Committee, and the Lands and Livestock Branches of Saskatchewan Agriculture, who provided financial support, land, some pasture facilities, administrative services, and the cattle required not only for the pasture research but for many nutritional and management studies carried out with the progeny of the cow herd.

The author is particularly appreciative of the help of Drs. Bittman, Cohen, Robertson and Waddington who reviewed the original manuscript and made many helpful suggestions for improving it.

The author also wishes to express his thanks to Dr. H.R. Davidson, current Director of the Melfort Research Station, for providing the secretarial help and other station resources involved in the preparation of this manuscript.

The author wishes to express his deep appreciation and thanks to Mrs. Susan Wittig, Secretary to the Director, Melfort Research Station, who prepared the manuscript and assisted in the preparation of charts and graphs.

S.E. Beacom
Director Melfort Research Station, 1966-1989
Research Scientist, Ruminant Nutrition and
Forage Utilization, 1952-1966

INTRODUCTION

La tremblaie (fig. 1) constitue une partie importante des terres agricoles dans les trois provinces des Prairies. Elle comprend les sols noirs (chernozémiques), noirs dégradés et gris boisés (luvisols) et s'étend généralement entre la forêt boréale au nord et la prairie au sud. Elle se caractérise par la présence de trembles et de peupliers baumiers, formant des peuplements continus et exploitables le long de la forêt, mais aussi par des bocages courts et dispersés, restreints aux zones basses et humides dans le sud. La topographie est variable, la région étant normalement plate à légèrement ondulée. La majeure partie du couvert végétal naturel a disparu depuis les années 1940, car on y abat les arbres pour élargir la surface cultivable afin d'y produire surtout des plantes annuelles. La productivité des sols varie d'excellente sur les loams limono-argileux très noirs à faible sur certains sols gris boisés. La moyenne des précipitations se situe entre 40 et 45 cm par année, environ 22 à 25 cm tombant durant la saison de croissance. La valorisation de l'eau (vitesse d'évapotranspiration) est positive, bien que, avec la réduction constante du couvert végétal, la vitesse d'évaporation aille en augmentant.

En Saskatchewan, les zones pédologiques qui comprennent la tremblaie représentent environ 41 % de la surface agricole (ou 11,6 millions d'ha). On estime que 3,4 millions d'ha (terres de classe 5 et 6) dans ces zones pédologiques sont utilisés principalement comme pâtures et qu'en plus une forte proportion des terres marginales (classe 4) sert soit au pâturage soit à la production de foin (tableau 1).

En Alberta, 54,5 % des terres agricoles (améliorées et non améliorées) font partie des zones de sols noirs et de luvisols. Dans ces zones, environ 36,4 % de la superficie (ou 3,7 millions d'ha) est exploitée comme pâturages.

Au Manitoba, où l'on compte 7,7 millions d'ha de terres agricoles, 25,7 % sont des pâturages (274 000 ha améliorés et 1,71 million non améliorés). La plupart des terres agricoles du Manitoba font partie de la tremblaie pour ce qui est du type de sol et du climat.

On trouvera au tableau 2 des données météorologiques pour certains endroits de la tremblaie.

Sur la majeure partie de la superficie, les travaux culturaux mis en oeuvre pour réaliser une rotation de céréales, d'oléagineux et de jachères ont entraîné une dégradation considérable des sols, en favorisant l'érosion par le vent et l'eau et l'apparition d'étendues salines. Là où ce phénomène s'est produit, on constate l'exploitation croissante de cultures fourragères vivaces soit pour le pâturage, soit pour l'affouragement, tout dépendant dans une certaine mesure de la facilité avec laquelle les terres peuvent être travaillées ou moissonnées.

Sur les sols les plus productifs, on note la tendance des producteurs à s'adonner à des pratiques culturales continues, y compris la culcure de légumineuses bisannuelles ou vivaces. Dans les régions salines, une graminée vivace, comme l'agropyre allongé, peut être cultivée pour régénérer le sol. Dans la plupart des cas, l'herbe cultivée sur les sols particulièrement productifs est utilisée pour la fauche ou l'ensilage, plutôt que pour le pâturage, tandis que les pâtures sont plus fréquentes sur les sols difficiles à travailler, moins productifs et sensibles à l'érosion.

La présente publication fournit des données obtenues au moyen d'essais de broutage réalisés à la Station de recherches de Melfort, dans le cadre du projet de broutage de Pathlow et à la Station de recherches de Termuende à Lanigan de même que de l'information extraite d'autres sources situées dans les zones des sols noirs et gris boisés. Elle est écrite surtout à l'intention des éleveurs qui désirent rendre leur exploitation plus efficace ainsi que des agronomes et étudiants qui s'intéressent à la production du bétail et des fourrages.

Le succès de n'importe quelle entreprise herbagère dépend de nombreux facteurs qui jouent non seulement sur le rendement et la qualité des herbes à brouter, mais aussi sur la réponse de l'animal brouteur. En plus des facteurs biologiques, entrent en jeu des facteurs économiques qui échappent en grande partie, voire totalement, au contrôle du producteur. Malgré une excellente gestion des prairies et pâturages, acheter des bovins chers et les vendre à bas prix peut se solder par un désastre financier. Pour réussir, il faut être un bon exploitant, mais aussi avoir le sens des affaires.

La plupart des projets de recherche suivent une démarche stricte, prédéterminée, contrairement à ce que fait le gestionnaire de pâturages à l'esprit pratique qui doit se montrer très souple dans son processus décisionnel. Par exemple, dans les expériences de broutage, on prévoit rarement de récolter, pour l'affouragement, l'herbe qui reste sur la pâture ou de servir des provendes produites à l'extérieur du pâturage, et pourtant c'est l'approche la plus pratique pour une utilisation efficace des bovins et des pâturages dans la majeure partie de la tremblaie. C'est pourquoi nous avons inclus à la fin de cette publication un exemple hypothétique d'un système de conduite des pâturages.

On considère que la région à laquelle s'applique ce projet de recherche est la tremblaie de l'Ouest canadien, comprenant les zones de sols noirs, noirs épais, gris foncé, gris foncé et gris foncé boisés de transition de même que gris boisés.

INTRODUCTION

The Aspen Parkland (Fig. 1) constitutes a major portion of the agricultural land in the three prairie provinces. It comprises the Black (Chernozemic), degraded Black and Gray-wooded (Luvisolic) soils and is located generally between the boreal forest to the north and the prairie region to the south. It is characterized by trembling aspen and balsam poplar, with stands ranging from continuous and mature, along the forest edge, to interspersed shorter bluffs restricted to the lower, moister areas in the south. The area is of varying topography normally flat to gently rolling. Much of the natural tree cover has been cleared since the 1940's to provide an expanded land base for agricultural crops, mainly annuals. Productivity of the soils range from excellent on the deep black silty clay loams to low on some of the gray wooded soils. Precipitation averages around 40-45 cm annually with about 22-25 cm falling during the growing season. Moisture efficiency (evapotranspiration rate) is favorable, although with the continuing reduction of tree cover, evaporation rate is increasing.

Fig. 1. The Aspen Parkland of Western Canada (lightly shaded area).

In Saskatchewan, the soil zones which comprise the Aspen Parkbelt account for about 41% (or 11.6 million ha) of the agricultural land. It is estimated that 3.4 million hectares (Class 5 and 6 land) within these soil zones are used primarily for pasture and that, in addition, a large part of the marginal land (Class 4) is utilized for either pasture or hay production (Table 1).

Table 1. The Percentage of Arable, Marginal, Non-Arable and Cultivated Land Within the Major Soil Zones Comprising the Aspen Parkbelt of Saskatchewan

Soil zone	Classes 1-3 (arable)	Class 4 (marginal)	Classes 5 & 6 (pasture)	Total acres cultivated (percent)	% of total agricultural land area	Total Area (ha)
Black	63.4	7.0	29.1	60.9	21.4	6,043,669
Thick Black	69.7	3.1	26.7	67.8	5.2	1,457,890
Dark Gray	72.0	3.6	22.6	54.5	1.7	480,095
Transition	71.0	3.3	24.3	62.8	7.2	2,039,058
Gray Wooded	49.0	7.0	42.0	24.6	5.6	1,589,590

In Alberta 54.5% of farmland (improved and unimproved) is included in the Black and Luvisol soil zones. Within these soil zones about 36.4% (or 3.7 million ha) are in pasture.

In Manitoba, with 7.7 million ha of agricultural land, 25.7% is in pasture (274,000 ha in improved pasture and 1.71 million ha in unimproved pasture). Most of Manitoba's agricultural land falls within the Aspen Parkbelt, in terms of type of soil and climate.

Meteorological data for selected locations within the Aspen Parkland are summarized in Table 2.

In much of the area, farming practices involved in a grain, oilseed and summerfallow rotation have led to considerable soil degradation by wind and water erosion and to the development of saline patches. Where this has occurred it has led to increasing use of perennial forage crops for either pasture or hay, depending to some extent on the ease with which the land could be tilled or harvested.

On the most productive soils there is a trend towards continuous cropping practices including the growing of biennial or perennial legumes. In saline areas a perennial grass such as tall wheatgrass can be grown to rejuvenate the soil. In most cases forages grown on the more productive

Soils are utilized for hay or silage rather than for pasture, while pastures are more prevalent on harder to work, less productive, erosion-prone soils.

This bulletin provides data obtained from grazing trials conducted at the Melfort Research Station, the Pathlov grazing project and the Termuende Research Station at Lanigan as well as information from other sources within the Black and Gray-wooded soil zones. It is written primarily for livestock producers who wish to improve the efficiency of their pasture operation and for agronomists and students interested in livestock and forage production.

The success of any pasture enterprise is dependent on numerous factors affecting not only the yield and quality of pasture herbage but the response of the grazing animal. In addition to the biological factors, there are economic factors over which the producer has very little, if any control. Despite excellent management of pasture and grass, buying cattle high and selling low can mean financial disaster. Operator plus business skills are required.

Most research projects follow a strict, pre-determined protocol unlike the practical pasture manager who must be very flexible in his decision-making. For example, "grazing" experiments rarely provide for the harvesting of excess pasturage as hay or the unplanned feeding of non-pasture feedstuffs, yet this is the most practical approach to effective utilization of both cattle and pasture in much of the Aspen Parklands. For this reason we have included at the end of this publication a hypothetical example of a pasture system.

It is considered that the area to which this research report is applicable, is the Aspen Parkbelt of western Canada, comprising the Black, Thick Black, Dark Gray, Transition Dark Gray and Dark Gray Wooded, and the Gray Wooded soil zones.

Table 2. A comparison of growing conditions at Brandon, Melfort, Pathlov, Vegreville and Lacombe

	Brandon	Melfort	Pathlov	Vegreville	Lacombe
Period (years)	99	30	15	32	82
Frost-free period (0 C)	105	101	-	87	92
Killing frost-free period (-2 C)	124	128	-	100	122
Mean Temperature (C)					
April	5.7	1.3	-	3.3	3.7
May	14.4	10.3	-	10.4	9.8
June	22.3	15.3	-	14.6	13.6
July	20.5	17.4	-	16.5	16.1
August	19.0	16.1	-	15.3	14.8
September	12.3	10.3	-	9.7	10.0
October	4.0	4.2	-	4.4	4.6
Precipitation (mm)					
April	30.1	18.9	-	15.7	27.6
May	48.5	38.3	51.0*	38.0	49.3
June	78.6	71.0	67.7	72.8	80.7
July	70.9	64.4	78.0	79.1	77.1
August	64.1	54.4	56.4	62.9	64.0
September	47.3	40.8	44.5	44.2	42.3
October	26.5	26.5	22.5*	16.1	19.2

*4 year's data missing for May; 2 year data missing for October.

COMPONENTS OF THE PASTURE SYSTEM

The management of a pasture enterprise is a complex matter. There are many factors influencing not only the performance of the grazing animal but the yield and quality of the herbage. The majority of these factors can be controlled by the pasture manager while others, such as weather and soil conditions are largely beyond his control. Many factors require the exercise of considerable judgment, such as when to put cattle on pasture, what stocking rate to use and when to move cattle from one field to another so that optimal production of both cattle and pasture can be achieved. Figure 2 organizes the factors which determine the amount of liveweight gain which a given area of pasture can produce.

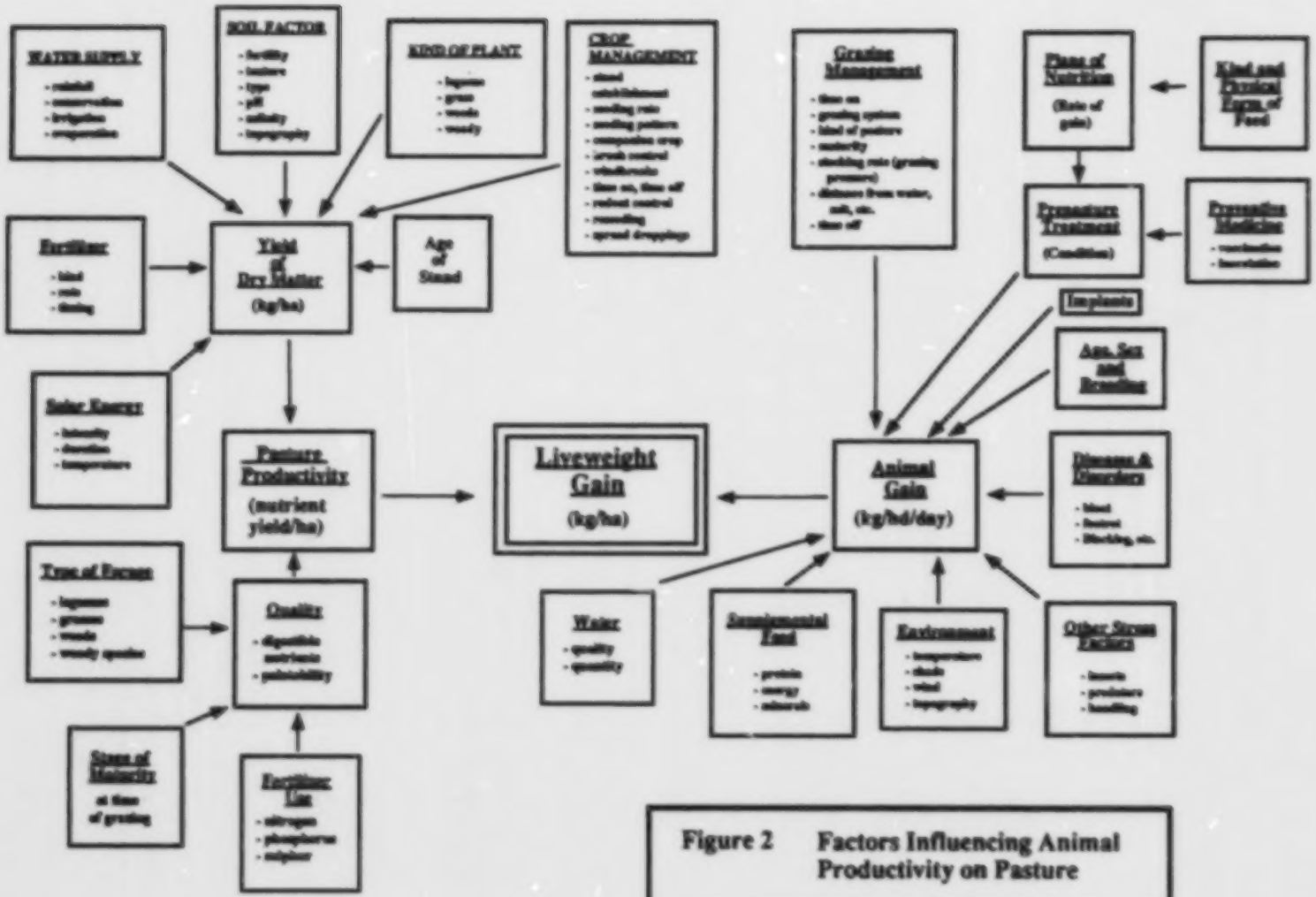


Figure 2 **Factors Influencing Animal Productivity on Pasture**

PASTURE - ADVANTAGES AND DISADVANTAGES

ADVANTAGES

1) Pasture provides the only system capable of utilizing plant growth on untillable, machine inaccessible land, for the production of high quality food for humans (includes both domesticated and wild ruminant species).

2) Pasture is a relatively lov cost production system, minimizing seed, tillage and harvesting costs compared to annual crop production, and usually involving a lover investment in labor, facilities, and equipment than other cattle production systems.

3) If well managed, pasture can provide most of the nutrients (except some minerals) in adequate quantities to meet the needs of ruminant livestock.

4) Animal wastes are automatically returned to the soil, minimizing net nutrient loss to the soil, and avoiding the manure handling problems associated with some other livestock production systems.

5) Cattle on pasture have a better environment than those in the feedlot, less exposure to disease, digestive disturbances and parasites, and of importance to breeding stock, more opportunity for exercise.

6) Well managed pasture systems provide year-round protection of the soil from erosion, and tend to be less ecologically damaging than annual crop production practices.

7) Pasture operations are much less dependent on the weather than are other cropping systems, - no annual seeding and harvesting operations. The stand is in place to take immediate advantage of favorable growing conditions.

DISADVANTAGES

1) Fencing and water system costs can be high, particularly in complex rotational grazing systems.

2) It is usually more difficult to inspect cattle on pasture and to administer treatments than in the feedlot.

3) Pasture productivity is not uniform between years or within grazing seasons, which requires a high level of management to meet the nutrient requirements of the cattle while optimizing the efficiency of pasture use.

4) There is a greater possibility of injury and losses due to predators and rustlers, particularly on isolated, rough bushland pastures.

5) Brush control can be a problem in Parkland pastures.

6) Because of selective grazing by the animal, maintaining the desired species composition and uniformity of utilization is more difficult than under a haying operation.

RATIONALE FOR PASTURE RESEARCH

Pasture research in the prairie provinces has been conducted primarily in the short grass ranges in the south (Manyberries, Swift Current), because the cow-calf segment of the beef industry was concentrated in that area. Recent livestock population figures show that an increase in the number of cattle in the Black and Gray-Wooded soil zones, probably because any expansion of the beef breeding herd must take place where the pasture and feed resources will assure a reliable feed base for the livestock. Chronic overgrazing and feed shortage in the south have necessitated this. In Saskatchewan, 49% of the beef cattle are to be found in the Black and Gray-Wooded soil zones.

Because pasture technology developed in the south does not apply to the north, it was imperative that a comprehensive pasture research program be developed to meet the needs of beef cattle producers in the northern parkbelt.

Pasture productivity varies considerably within the Aspen Parkbelt. On native pasture in the interlake region of Manitoba, 3 to 22 kg of liveweight gain per ha have been reported, while cultivated pastures have produced from 78 to 336 kg of liveweight gain per ha.

At Lacombe, gains on dryland brome-alfalfa pastures have ranged from 180 to 437 kg/ha depending on the level of fertilizer applied.

At Beaverlodge, carrying capacities have increased from 16-24 ha per steer to 1.5 to 2 ha per steer by improving the range, and at Brandon, a combination of crested wheatgrass-bromegrass and Russian wild rye produced 2 to 3 times as much as did native pasture and provided a better seasonal distribution.

Work at the Melfort Station was initiated in 1954 with grazing steers on productive soils and was accelerated in 1974 with the initiation of a major cow-calf pasture research project on the relatively unproductive gray-wooded soils at the Pathlow Community Pasture.

Variation in pasture productivity in northeastern Saskatchewan (Melfort and Pathlow) is reported in detail elsewhere in this publication.

FACTORS AFFECTING THE CHOICE OF A PASTURE SPECIES

The most important considerations in selecting a pasture species are its ease of establishment, its ability to produce under the soil and climatic conditions involved, its competitiveness with weeds and seasonality of production. To a considerable extent, yield and nutritional quality can be influenced by management*. The key factors, not necessarily in order of importance, that should be considered when slecting a forage species or variety are listed below.

1) The productive potential of the species or variety when grazed.

2) The persistence of the species or mixture over the expected productive lifetime of the stand.

3) The competitiveness of the species if grown in mixtures or on land contaminated with seed or seedlings of "unvanted" species.

4) Seasonality of production - especially the ability to provide early and/or late season grazing in a multi-species rotational grazing system.

5) The ease of establishment or cost of establishment relative to the productive potential of that species.

6) The type of soil - pH, salinity, drainage, possibility of flooding, erodibility, fertility.

7) The class of livestock being grazed.

8) Growing conditions - moisture, temperature, severity of the winter, sunlight, availability of protective snow cover, etc..

9) Presence of toxic factors or bloat-causing properties.

10) Resistance to herbicides required to kill problem weeds.

11) Resistance to disease and insects likely to cause problems in the area.

---

*For additional information on forage crop production see "Forage Crop Production in the Aspen Parklands of Western Canada" (Publication 1545, revised 1990), and for information on forage crop quality and utilization see Utilizing Harvested Forages in the Aspen Parklands of Western Canada (Publication 1548, revised 1990.)

FORAGE SPECIES COMMONLY GROWN FOR PASTURE IN THE ASPEN PARKBELT

Note: More detailed information of forage species is contained in the companion publication "Forage Crop Production in the Aspen Parklands of Western Canada". Information in this publication is limited to species adaptation, and grazing management. Varieties listed should be checked with your nearest forage agronomist, as new varieties are constantly being developed and older varieties deleted from the "recommended" list.

PERENNIAL LEGUMES

Alfalfa

Varieties for pasture

- Drylander, Heinrichs, Rambler, Rangelander and Roamer

Adaptation

- Prefers deep, well-drained loam with high calcium content (pH 6.3-7.5).
- Good cold tolerance.
- Good drought tolerance.
- Will not tolerate flooding for longer than 2 weeks.
- Requires a lot of water per unit of dry matter produced (800:1).

Nutritive value

- At the flowering stage leaf:stem ratio is about equal, with leaves containing 24-25% crude protein and stems containing 8-10%. A very palatable pasture species.

Grazing management

- May cause bloat if grazed at the bud stage or earlier, thus it is normally sown in combination with a grass.
- Graze no closer than 10 cm, leave a good stubble to trap snow overwinter.
- If feeding grain on pasture in late summer watch for disproportionate regrowth of alfalfa in a mixed stand. It could cause bloat, particularly if the grain is being self-fed.
- If possible, particularly if there has been no rest period during the grazing season, avoid grazing for a 4 week period preceding the normal date of the first killing frost. This allows time for food reserves to accumulate in the roots to enable the plants to respire through the winter and initiate growth in spring.
- To maintain proportion of alfalfa in the pasture, allow rest periods for recovery (to bud stage), fertilize with P_2O_5 and S to meet alfalfa requirements, don't overgraze. Fertilizing with nitrogen will

encourage the grass component of the mixed stand to the detriment of the legume, thus overall yield of pasture and proportion of alfalfa may be in conflict. Some varieties or strains are much more persistent than others when grown with smooth bromegrass (see Table 3).

Table 3. Persistence of Alfalfa Varieties Seeded in Mixtures with Smooth Bromegrass (Seeded in 1980, Rated in 1987)

Variety	% Stand	Plants/m^2
Beaver	7	3.8
Rambler	21	6.6
Peace	15	4.2
Drylander	30	8.7
Rangelander	20	8.1
SCMF 3713*	62	15.6

*An unlicensed strain.

Source: Dr. S. Bittman

Persistence of alfalfa is closely related to the degree of fall dormancy. Cultivars that produce well in the fall will not persist as long as those that become dormant early in the fall. Other factors affecting persistence are selective grazing of the alfalfa in grass-alfalfa pastures, competition from other forage species (grasses) and nutrient availability in the soil.

Sainfoin

Varieties

- Nova, Melrose

Adaptation

- Prefers calcareous soils but does well on thin and gravely soils.
- Less drought and cold tolerant than alfalfa: does not persist as long, requires at least 300 mm rainfall annually.
- Tolerates high alkalinity, early spring and fall frosts.
- Intolerant of acidity, salinity, flooding, waterlogging and high water table.

Nutrient value

- Slightly lower in crude protein content than alfalfa at comparable stages of maturity.
- Highly palatable.
- Does not cause bloat.

Grazing management

- Grow alone or with a bunch type grass (Russian wild rye or crested wheatgrass) - not with a rhizomatous rooted species such as bromegrass.
- Graze at the bud or early bloom stage and graze above 20 cm to encourage regrowth and a longer productive life.
- If in a mixture, allow a recovery period, preferably by using at least a four-field rotational grazing system. Continuous grazing in a grass mixture will result in the sainfoin being grazed out within two to three years.
- At Melfort it has been observed that given a choice, pocket gophers will avoid sainfoin roots in favor of alfalfa roots.

Birdsfoot trefoil

Varieties

- Cree, Leo

Adaptation

- Grows best in Gray Luvisol and Black soils.
- Tolerant of water logged soils and withstands several weeks of flooding.
- Tolerant of some acidity.
- Tolerant of low fertility, may be useful on organic soils.
- Withstands high alkalinity and some salinity.
- Not tolerant of drought.
- Not as winter-hardy as alfalfa.
- Tends to reseed itself.

Nutrient value

- A non bloat-causing legume.
- Highly palatable and nutritious pasture.

Grazing management

- Withstands grazing well.
- Avoid overgrazing as the species is highly palatable.

- Good production throughout the grazing season but requires 4 to 6 weeks between grazings.
- Do not allow root reserves to become depleted.

Alsike clover

Varieties

- Aurora, Dawn

Adaptation

- Prefers cool, moist growing conditions.
- Well suited to acidic, organic soils, Gray Luvisol soils and heavy, moist alkaline soils.
- Does not tolerate salinity, drought or shade.
- Tolerates spring flooding (6 weeks).
- Has excellent winter hardiness.

Nutrient value

- Very palatable, high protein pasture.
- Will cause bloat.

Grazing management

- Grow alone or in combination with timothy.
- Often grazed following a hay cut.
- Late grazing will not deplete root reserves or affect winter survival.
- Stands normally productive for only two to three years.
- Although short-lived, it will reseed itself in pastures.

Red clover

Varieties

- Altaswede, Norlac (use single cut cultivars only)

Adaptation

- Prefers humid areas with moderate temperatures.
- Recommended for moist areas of the Gray Luvisol and Black soil zones.
- Tolerant of acid soils > ph 5.0, and cold.
- Less adapted than Alsike clover to poorly drained soil.
- Short-lived, 3 years.
- Single cut varieties persist for 2-3 years.

Nutrient value

- A very palatable, high protein pasture.
- Will cause bloat.

Grazing management

- Frequently grazed following a hay crop.
- Fall grazing not critical to root reserves.
- Take normal precautions for bloat prevention.

Cicer milkvetch

Varieties

- Oxley

Adaptation

- Moderately salt tolerant and drought tolerant.
- Very winterhardy and frost tolerant in fall.
- Probably not flooding tolerant.
- Prefers medium to coarse textured soils.

Nutrient value

- Cicer milkvetch does not cause bloat or accumulate toxic levels of selenium.
- Cicer milkvetch retains its leaves and nutritional quality late into the fall.
- Palatability of cicer milkvetch relative to associated grasses is low in spring but improves to a high level in fall.

Grazing management

- Begins growth late in spring (well after alfalfa).
- Resists damage by pocket gophers.
- Recovers slowly after cutting.
- Excellent potential for fall grazing of spring growth because of leaf retention, frost resistance, and fall palatability.
- May combine well with crested wheatgrass for early spring (before cicer milkvetch begins growth and late fall growth).

BIENNIAL LEGUME

Sweet clover

Varieties for pasture

- Low coumarin varieties: Polara (white flowered), Norgold (yellow flowered). Yellow flowered varieties are shorter and more palatable than white flowered varieties.

Adaptation

- Prefers fertile, well-drained clay and clay loam soils but can be successfully grown on sandy and heavy clay loams, and on gray-wooded soils.
- Prefers neutral to alkaline soils and tolerates saline and alkaline soils better than any other cultivated legumes.
- Intolerant of flooding and acidity. Tolerates some salinity.
- Has good drought resistance.

Nutrient value

- Very palatable, high protein pasture.
- Can cause bloat.

Grazing management

- Maintain a height of about 30 cm to keep production in the vegetative state and to allow light to reach the lower portions of the plant for photosynthesis and active bud growth.
- At the end of the growing period, pasture may be grazed down without causing damage the following year.
- Watch for bloat and take the usual precautionary measures, such as avoiding young succulent growth or providing dry roughage on pasture.

PERENNIAL GRASSES

Smooth bromegrass

Varieties

- Carlton, Magna, Rebound, Signal

Adaptation

- Wide adaptation, most prominent grass in the Aspen Parkland.
- Prefers cool, moist conditions, but is very drought resistant.
- Adapted to well drained areas of the Black and Gray Luvisol soil zones. Extremely winter hardy, persistent and competitive with weeds.

- Tolerates alkalinity, and some salinity and acidity.
- Withstands early spring flooding for about two weeks.

Nutritive value

- Good protein levels compared to other grasses of similar maturity.
- Quite palatable, especially if kept in the vegetative state.
- Vegetative tillers have twice the leaf tissue of seed producing tillers, thus are more palatable and nutritious. The cultivar "Rebound" has a high proportion of non-flovering (vegetative) tillers.

Grazing management

- Spring growth is later than Russian wild rye, crested wheatgrass and meadow bromegrass but earlier than intermediate wheatgrass.
- Susceptible to overgrazing particularly during stem elongation, in which case it will be replaced by Kentucky bluegrass, creeping red fescue and broad-leaved weeds. Produces best under rotational grazing where it can be lightly grazed at the beginning of the season to keep the plant in the vegetative state. Regrovth in summer and fall is slov. If grovn with alfalfa, greater late season regrovth of alfalfa relative to brome, can cause bloat, particularly if grain is being self-fed.
- Heading occurs about 1 veek after crested wheatgrass and one veek before intermediate wheatgrass.

Crested wheatgrass

Varieties

- Parkvay and Fairvay (shorter, leafier and more persistent than southern cultivars). Kirk may be grown in the Parkland areas bordering the dark brovn soil zone.

Adaptation

- Well adapted to the drier areas of the Black soil zone, but does vell on most good soils, heavy clay loam, heavy clay and Gray Luvisolic. It will establish on sandy soil. While adapted to dry conditions, it will produce when moisture conditions are good. It is very winter hardy and persistent.
- It is tolerant of high alkalinity with only fair tolerance to alkali salts and acidity.
- It will not tolerate spring flooding or a high vater table.

Nutritive value

- Crested vheatgrass is palatable prior to setting seed, and produces about 10% more liveveight gain per unit of dry matter consumed than

other forages at comparable stages of maturity up to time of setting seed (whether as pasture or hay).

Grazing management

- Is one of the first species to provide grazing in the spring (second to Russian wildrye). Fertilizing can advance spring grazing by one week.
- Provide sufficient grazing pressure to prevent heading, otherwise headed plants are ignored and regrowth is grazed.
- Pasture will go dormant during dry spells and recover when temperatures cool and moisture levels improve. Unlike smooth bromegrass, leaves of crested wheatgrass will turn brown and die rapidly in dry weather.
- This pasture should be used in conjunction with other species in a rotational system and utilized heavily at the beginning of the grazing season, and as appropriate if moisture conditions permit regrowth later in the season.
- Will withstand close grazing but not overgrazing. Leave at least 5 cm growth at the end of the season to trap snow.
- Occasionally the milk from dairy cows grazing crested wheatgrass in the early spring may develop an objectionable flavor. This can be overcome by removing cattle from pasture 2-3 hours prior to milking.

Russian wildrye

Varieties

- Swift, Mayak, Tetracan

Adaptation

- Well adapted to the loam and clay loam soils in the drier parts of the Black soil zone, but can be grown on a fairly wide range of soil types. Difficult to establish on sandy soils or where there is a lot of competition from weeds and other plants. Suitability for Gray-wooded soil is unproven and test strips are recommended.
- Fairly tolerant of alkalinity and highly tolerant of cold, drought and moderately tolerant to salinity.
- Does not tolerate spring flooding and is not adapted to cool, moist conditions.

Nutritive value

- Compares favorably with other common grasses. Cattle may prefer other species (including weeds) but do well on Russian wildrye, if there is no choice.

Grazing management

- The earliest available pasture species in the Aspen Parkbelt. It has a long season of growth and is particularly useful for late season grazing. When used for both early and late grazing, a mid-season recovery period is required. New stands should be allowed to mature and set seed before being grazed which normally means no grazing in the year of seeding.
- Russian wild rye pasture needs to be fenced and used in a rotational grazing system. Cattle tend to find it somewhat less palatable than other species or even some weeds, but perform well if given no choice.
- When used for seed production, it is desirable to graze the crop immediately after seed is harvested.

Intermediate wheatgrass

Varieties

- Chief, Clarke

Adaptation

- Prefers well-drained soils with adequate precipitation (more than 37.5 mm/year) (Black soil zone).
- Tolerates alkalinity.
- Less drought resistant and winter hardy than crested wheatgrass.
- Does not tolerate salinity, flooding or poor drainage.

Nutritive value

- Very palatable, high quality pasture if grazed in the vegetative state. After stem elongation, herbage becomes stemmy, and palatability and quality declines rapidly.

Grazing management

- Less competitive than smooth bromegrass which, for shorter pasture programs, makes it ideal in combination with alfalfa.
- Provides excellent pasture from early spring to late fall, if managed to prevent heading.
- Most growth is produced in the first half of the grazing season but regrowth is usually better than for smooth bromegrass.
- Pasture stands do not remain productive for much more than 5 years. After 7 years, a stand at Melfort had been partially replaced with other more competitive species.
- Stemmy growth is difficult to graze evenly and declines rapidly in quality. Ungrazed stems will suppress regrowth.
- Heads out 10-14 days after crested wheatgrass and smooth bromegrass, hence is useful for complementary grazing.

Tall wheatgrass (a late-maturing bunchgrass)

Varieties

- Orbit

Adaptation

- Very saline tolerant (up to 15 mmhos) - useful for rejuvenating saline land (either alone or, preferably, with sweetclover or alfalfa) by helping to lover vater table.
- Prefers soils vith a high vater table, does not persist on dryland soils.
- Tolerates flooding (8 veeks), poorly drained soils, and moist, moderately alkaline soils.
- Has good vinter hardiness.
- Has lov drought tolerance.

Nutritive value

- Excellent feeding value vhen grazed before fully headed.
- Not as palatable as other pasture grasses but readily accepted if given no choice.

Grazing management

- The stand is slov to establish and does not compete vell vith veeds during the establishment year.
- Be sure that the soil is dry and firm and the "sod" vell established, to prevent damage by grazing cattle before pasturing.
- Because the crop is late maturing, it provides a long grazing season.
- Should be grazed heavily to maintain stand in a vegetative state, otherwise becomes coarse and unpalatable.
- Leave a 15 cm stubble to discourage close grazing the next season.

Reed canarygrass

Varieties

- Rival, Vantage, Venture (all lov alkaloid)

Adaptation

- Not tolerant to salinity.
- Very tolerant of flooding (up to 2 months) and a high vater table.
- Vithstands some acidity and alkalinity, and tolerates moderate drought.
- Moderately vinter hardy.

Nutritive value

- Coarse, but leafy growth has good nutritional value and high protein content.
- Alkaloid containing varieties can be unpalatable, limiting intake and animal performance.
- Spring growth becomes very tall and coarse, and almost impossible to graze if not kept under control.
- Regrowth is short, uniform, very leafy and provides excellent grazing.

Grazing management

- Reed canarygrass can be relatively unpalatable, hence cattle will have to be fenced onto it in order to ensure consumption. It would seem preferable to use this kind of pasture as one component of a rotational grazing system.
- Be sure that newly seeded stands are well enough established that they will not be physically damaged by the cattle.
- Pasture is available moderately early in spring and has good seasonal growth distribution.
- Graze before reaching 30 cm high and not shorter than 10 cm.
- Leave 15 cm stubble in fall to trap snow, prevent winterkill.
- Because it often grows in flooded areas it may be difficult (or impossible) to graze or harvest at an ideal stage of maturity. Once established, the strong sod will support some traffic. Attempt to utilize as early as possible, consistent with moisture conditions.
- Reed canarygrass is difficult to manage because it is often difficult to harvest or graze early enough because of the wet conditions that it grows under. However, because it forms a strong sod, it will support some traffic, even on wet soils.

Meadow bromegrass

Varieties

- Fleet, Paddock, Regar

Adaptation

- Prefers slightly acid to slightly alkaline, well-drained soils.
- Survives drought, but leaves turn brown much more rapidly than smooth bromegrass.
- Less competitive with weeds and alfalfa than smooth bromegrass.
- Less winterhardy than smooth bromegrass.
- Establishes slowly and must be seeded on clean fields. Old bromegrass sod pieces will generate growth that will compete with meadow bromegrass.

Nutritive value

- Very palatable, more leafy growth than smooth bromegrass, better seasonal distribution of production (Table 4).

Grazing management

- Don't graze until stand reaches at least 25 cm.
- Remove animals when stand is 8-10 cm high.
- Allow 3-4 weeks between grazing.
- Is ready for grazing earlier than bromegrass, and because of its good recovery following initial grazing, helps to extend the pasture season.
- Leave 15 cm of stubble in the fall to permit replenishing of root reserves and to trap snow.
- The long-term persistence in pastures in the Parkbelt is still unproven.
- All bromegrasses may be injured by grazing during stem elongation because root reserves are at their lowest.

Table 4. Production of smooth bromegrass and meadow bromegrass under simulated grazing (1980-86)

Yield	Smooth Brome	Meadow Brome
	kg/ha	
Total	5070	5342
Regrowth	3367	3462
Late season	465	843

Source: Dr. S. Bittman

OTHER GRASS SPECIES

Several other species of forage crops will grow in the Aspen Parkland but they have characteristics that limit their usefulness.

Slender wheatgrass establishes well but is very short-lived (3 years). It is the only native North American grass commonly seeded in the Aspen Parkland. It is very salt tolerant. It consistently produces a crop in the year of seeding and may have a role when seeded with slower establishing species such as meadow bromegrass or Russian wildrye.

Altai wildrye has a deep root system that makes it drought tolerant, but it competes poorly with weeds, establishes slowly and seed is expensive. When it can reach the water table, it will produce well in the spring and summer, an important characteristic in a dry year.

Timothy grows reasonably well under good moisture conditions but is shallow-rooted, intolerant of drought, and yields much less than smooth bromegrass in the Melfort area.

Meadow foxtail tolerates flooding and spring frosts. It flowers early but spring growth is less than that of crested wheatgrass. Due to a shallow root system, total yield is very low. At Prince George, B.C., animal performance on meadow foxtail was poor and was adversely affected even after the forage was no longer fed.

Tall fescue and meadow fescue are not winterhardy in the Aspen Parkland.

Orchardgrass has excellent yield and regrowth potential but is not sufficiently winterhardy to be recommended.

Kentucky bluegrass and creeping red fescue are very winterhardy and found in bushland pastures, but their production is 60-70% of other cultivated grasses. Because of their low growing habit they will gradually take over under heavy grazing. Severe grazing will cause even these species to be replaced by less desirable species - everlasting, sedges and annual bluegrass.

A COMPARISON OF GRASS SPECIES FOR PASTURE IN NORTHEAST SASKATCHEWAN

The forest transition zone or Parkland (Black and Gray wooded soil zones) has shorter and cooler summers, and less evapotranspiration than the prairies. Pasture crops in the Parkland differ from their southern counterparts by being more productive overall and by producing more regrowth after grazing. A study was conducted to evaluate several forage species with contrasting growth habits and adaptation for use on black and gray-wooded soils in Northeast Saskatchewan.

Twenty forage species were seeded on a deep black soil (Melfort silty clay) in 1979 and fertilized annually with 90 kg N and 45 kg P_2O_5 per ha. The plots were cut either as hay (June 27 and September 17) or to simulate rotational grazing (June 2, July 1, August 6 and September 18). Plots were not cut on the final date in 1980, 1985 and 1986 because of insufficient regrowth.

Thirteen of the twenty species were seeded on a gray-wooded soil (Waitville loam) at the Pathlow project in 1980 and fertilized annually. Two harvesting systems (hay and simulated grazing) were used. Plots were cut as

hay on July 2 and September 22, and as simulated pasture on June 6, July 4, August 8, and September 11; no growth was available for harvesting on simulated grazing plots on the final date in 1981, 1984 and 1986.

Several species (orchardgrass, meadow fescue, tall fescue, reed canarygrass, tall wheatgrass, slender wheatgrass) had substantial loss of stand over the course of the experiments due to winterkill and other factors. Other species (timothy, meadow timothy, creeping red fescue, hard fescue, Kentucky bluegrass, meadow foxtail) had consistently low yields under all management systems. Altai wildrye was particularly prone to invasion by weeds. The information provided is confined to those species which showed the best overall performance (Table 5), and covers only the performance of the species under simulated grazing.

Table 5. Distribution of dry matter yields (kg/ha) for six grass species under simulated grazing on Black (1980-1986) and Gray-Wooded (1981-1986) soils (four cuts)*

	Black soil			Gray-Wooded soil		
Species	First cut	Last cut	Total	First cut	Last cut	Total
Crested wheatgrass	2236	414	5304	819	235	1896
Intermediate wheatgrass	1233	674	5994	460	233	1882
Smooth bromegrass	1238	465	5070	680	207	1881
Meadow bromegrass	1472	843	5432	602	329	2063
Russian wildrye	2160	324	4932	485	-	-
Green stipa (needlegrass)	1412	436	4987	484	291	1807

*90 kg N and 45 kg P_2O_5/ha annually.

Most of the grasses showed similar long term productivity, however, Russian wildrye became relatively more productive on black soil over the duration of the experiment while intermediate wheatgrass became less productive on both soil types. Yield decline in intermediate wheatgrass has also been reported in Alberta and may be due to lack of cold and drought resistance.

Table 6 summarizes attributes of the grasses discussed in relation to their suitability for pasture in northeast Saskatchevan.

Table 6. Comparison of Six Grass Species for Pastures in Northeast Saskatchewan

	Crested wheatgrass	Intermediate wheatgrass	Smooth bromegrass	Meadow bromegrass	Russian wildrye	Green stipa
PASTURE						
Total Yield (% of Mean)						
Black soil	100	107	95	101	100	96
Gray soil	103	95	98	108		95
Regrowth Yield (% of Mean)						
Black soil	82	126	102	111	80	100
Gray soil	77	102	92	116		114
Fall Regrowth (% of Mean)						
Black soil	66	129	83	147	76	100
Gray soil	71	87	70	151		120
Early Spring Production (% of Mean)						
Black soil	137	69	74	86	141	93
Gray soil	144	79	104	104	85	85
Ease of establishment	Good	Good	Good	Fair	Very slow	Slow
Longevity	Good	Fair	Good	Good*	Good	Good

*Requires long-term evaluation.

Smooth bromegrass is a reliable grass because it is very hardy, moderately high yielding, and not too difficult to establish. It heads out later than crested wheatgrass but earlier than intermediate wheatgrass.

Intermediate wheatgrass yielded most, particularly on black soil, but yield declined after 5-6 years. Yield decline may be related to lack of winterhardiness and drought resistance. Intermediate wheatgrass is late maturing but very stemmy and can be difficult to graze.

Russian wildrye is difficult to establish because its seedlings grow very slowly. Yield on black soil was low in the first year but highest in two of the last three years. Russian wildrye does not perform as well on Gray-wooded soil, perhaps because of poor subsoil structure restricting root development.

Green stipa is also quite difficult to establish and produces poorly in the first year. Production of green stipa was slightly lower than smooth bromegrass and other species. It had good regrowth on the Gray-wooded soil.

Meadow bromegrass is an excellent pasture grass because it has high yield, excellent regrowth and late summer productivity, and a high proportion

of leaf tissue. However, meadow bromegrass does not compete well with weeds, is more difficult to establish than smooth bromegrass, and questions remain about its long-term persistence. Based on our results, we strongly recommend gradual introduction of meadow bromegrass to pastures in the Parkland region.

ESTABLISHING A PRODUCTIVE PASTURE

The key to productive pasture stands lies in the practices followed during the establishment of that stand. These are summarized as follows:

1) Use clean land. Land polluted with weed seeds, woody species and other less desirable forage species must be cleaned up before attempting to seed with a more desirable forage species or mixture. Use of tillage, herbicides and cropping with annuals (such as oats and spring seeded winter wheat or fall rye) can be effective. Annuals should be removed as silage or grazed to prevent seed set of both the crop and associated weeds.

2) Select an appropriate forage species or variety for the soil type, growing conditions and planned use.

3) Use good seed, true to variety, with good germination and free of weed seeds and disease.

4) Inoculate legume seed with viable rhizobium of the right strain.

5) Seed into a firm, moist, seedbed. Direct seeding into clean stubble may also be satisfactory, and in some cases seeding into herbicide treated strips in an existing sod may work.

6) Seed perennial forages as early as possible in the spring or in late fall just prior to freeze-up after freeze-up. Some perennial grasses may be seeded in late August-early September.

7) Use the recommended seeding rate. Grasses, 7-11 kg/ha in most of the Aspen Parkland; Legumes in pasture mixtures @ 2-4 kg/ha (exception, Sainfoin @ 30-40 kg/ha in pure stands). Normally 200-450 seeds/m^2 (20-45 seeds/sq. ft.) depending on moisture conditions.

8) Seed in rows. Spacings in the Parkland should be 15, 30 or 46 cm (6, 12 or 18") depending on the species and the normal moisture conditions (wider rows yield more under drier conditions). Seeding different species (eg. alfalfa and crested wheatgrass) in alternate or cross rows is recommended for pastures (cross-seeding will help to control erosion on sloping land).

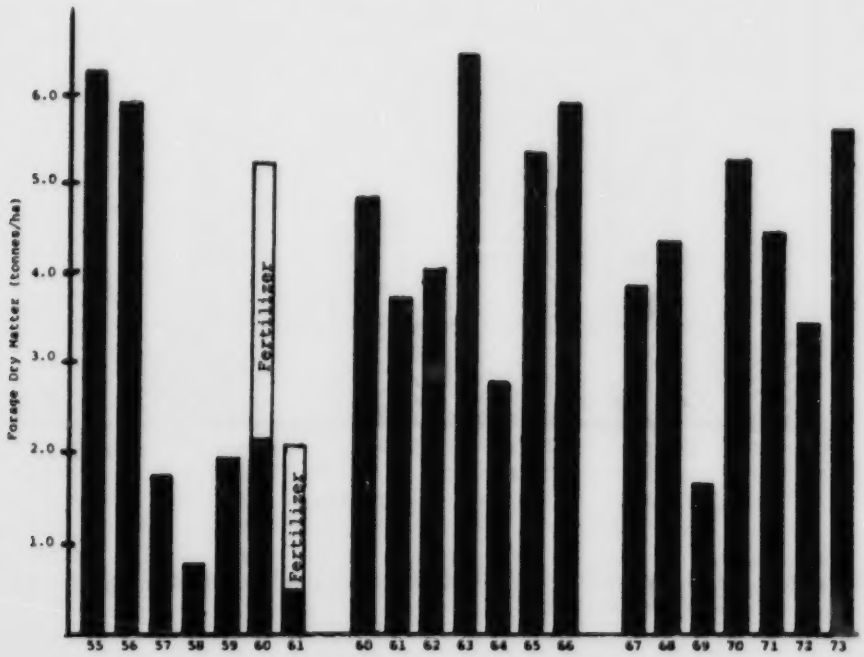
9) Don't use a companion crop except where there is a danger of erosion occurring before the crop becomes established or where the economic value of the companion crop will outweight the loss in forage production

during the first year or two. A companion crop competes for water and nutrients and shades the developing forage crop. If it must be used, seed at less than half the normal rate and harvest for hay or silage as early as possible, leaving a reasonable stubble to trap snow.

10) Don't graze the new stand before it is well established and the soil dry enough to prevent physical damage from grazing livestock.

VARIATIONS IN PASTURE PRODUCTIVITY

Forage yields depend primarily on the available moisture supply, sunlight, temperature, soil fertility and type of pasture management; with moisture supply the first limiting factor. Because rainfall varies considerably from year to year and within the growing season, pasture production also shows considerable variation. Figure 3 shows the production of pasture dry matter over each of three, seven year periods during which grazing trials were carried out on bromegrass-alfalfa pastures on a productive Black soil at Melfort. Table 7 and Figure 4 show the variability in animal gains that occur within the grazing season.



	55	56	57	58	59	60	61	60	61	62	63	64	65	66	67	68	69	70	71	72	73
Precipitation (cm)																					
Apr. 1 - Aug. 31	28	25	25	13	25	23	8	23	8	15	30	18	28	28	8	23	13	28	28	18	46
Prev. Oct. 1 - June 30	36	33	25	23	30	30	18	30	18	25	28	15	33	28	20	20	15	33	33	23	30
Nitrogen Fert. (kg/ha)	0	0	0	0	0	169 0	169 0	0	0	0	75	112	84	84	0	0	0	90	90	90	90

Fig. 3. Brome-alfalfa pasture dry matter production, Melfort, 1955-1973

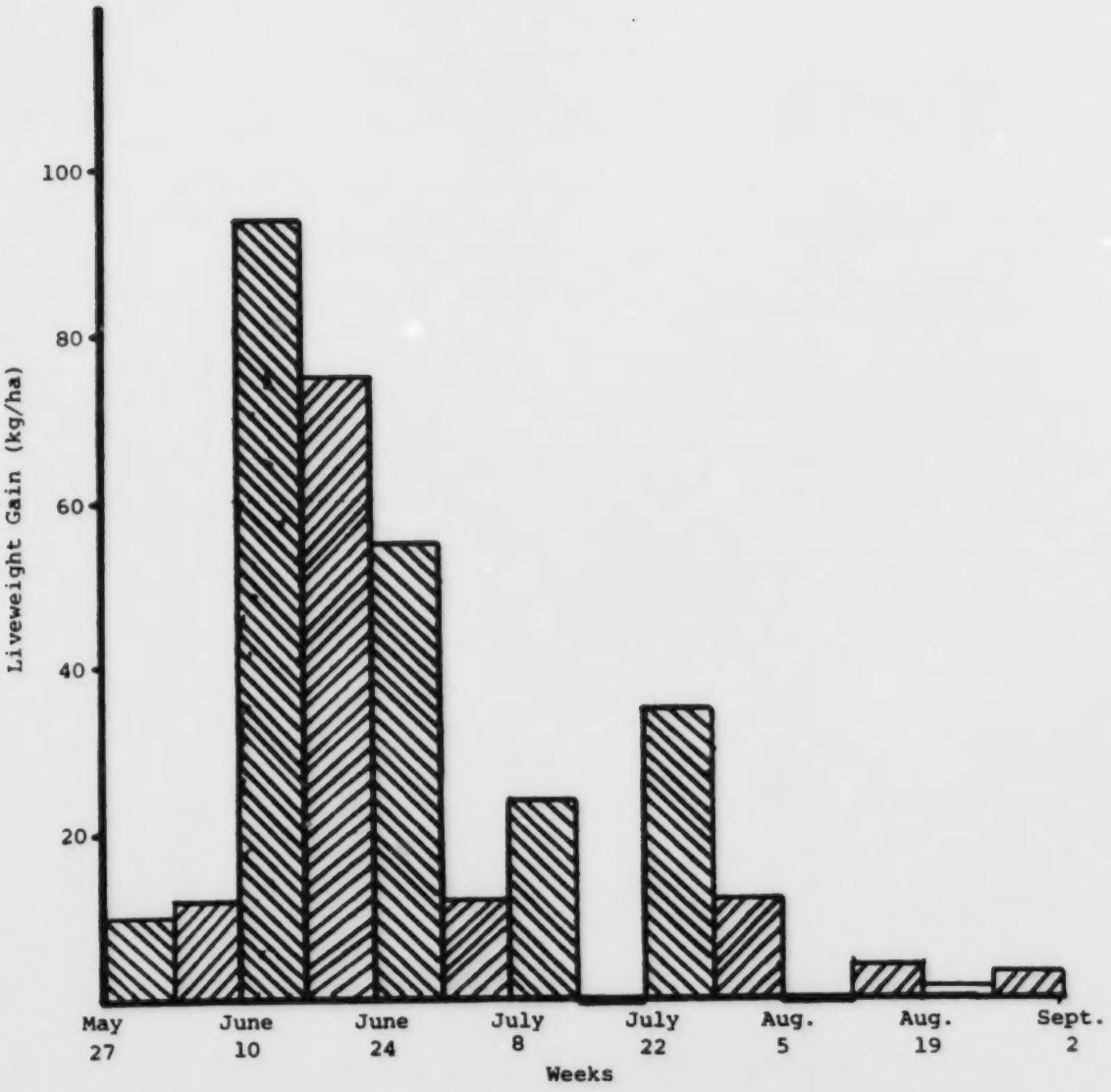


Fig. 4. Example seasonal fluctuation in liveweight gains on bromegrass-alfalfa pasture

Table 7. Variation in performance of yearling steers on continuously grazed bromegrass-alfalfa pastures

Year	Season (days)	Rainfall April 1 - Sept. 30 (cm)	Gain (kg/ha)	Av. daily gain (kg)	% Liveweight Gain by Quartile			
					1st	2nd	3rd	4th
Project A								
1955	91	31.2	204	0.85	26	27	28	19
1956	99	28.3	333	0.92	51	23	20	6
1957	99	27.9	249	0.94	57	18	13	12
1958	54	17.5	117	1.14	46	35	9	10
1959	105	35.6	182	0.92	46	22	24	8
1960	98	23.9	282	0.98	56	18	10	14
1961	46	10.5	143	1.15	40	18	24	18
Average	85	25.0	216	0.99	46	23	18	13
Project B								
1960	104	23.9	435	1.13	49	14	21	16
1961	69	10.5	262	1.00	38	42	15	5
1962	78	16.5	204	1.01	44	35	20	1
1963	117	32.6	423	0.98	42	30	17	11
1964	98	26.2	266	1.30	46	4	39	11
1965	92	34.8	387	1.05	47	35	15	3
1966	114	30.0	282	0.79	52	23	16	9
Average	96	24.9	323	1.03	46	24	19	11

OBSERVATIONS

1. Dry matter production was not particularly well related to rainfall over the growing season, probably due to the timing and intensity (amount) of rainfall.

2. Despite wide variations in pasture productivity from year to year, rate of animal gain was relatively constant, which is as it should be if grazing management was properly carried out. The possible exception is that during short seasons quality of pasture is normally superior to that over a long season due to the tendency for pasturage to become more mature as the season progresses. Thus there is a tendency for higher rates of gain in short grazing seasons and lower rates of gain over long grazing seasons.

3. On average, 46% of the liveweight gain produced on pasture occurred during the first quarter of the pasture season and 11-13% during the last quarter. Note that this occurred under continuous grazing of brome-alfalfa. This pattern would not likely be so extreme under a rotational grazing system

in which several different pasture species were grazed in rotation.

METHODS FOR BALANCING PASTURE SUPPLY TO SEASONAL LIVESTOCK DEMAND AND FOR EXTENDING THE GRAZING SEASON

1) Select a range of pasture species that have different seasonal growth patterns, examples:

- Russian wild rye, crested wheatgrass, fall rye (especially if fertilized) for early grazing.

- Bromegrass-alfalfa, meadow bromegrass-alfalfa for mid season grazing.

- Russian wild rye, meadow bromegrass, cicer milkvetch, annual ryegrasses (in moist areas) and cereal such as oats, spring-seeded winter wheat and fall rye, for late summer and fall grazing.

2) If practical, select a mix of cattle types or weights, some of which can be removed as pasture productivity declines, i.e. feeder steers could be placed with or following cow-calf units (in a rotational system) during the peak production period and removed to feedlot or annual pasture as the productivity of the perennial pasture declined. Calves could be weaned early and removed to supplementary pastures, allowing cows to recover some weight on the less nutritious late summer pastures, thereby reducing wintering costs.

3) Consider supplemental feeding of silage, soilage or grain on pasture to maintain a constant stocking rate. Excess pasture could be harvested (particularly in a rotational grazing system) for silage or hay and fed back to the cattle later in the season, or used for winter feed.

4) Application of fertilizer (providing there is adequate moisture) will cause earlier growth on pasture and could also be used (in split applications) to stimulate late season growth.

5) Adopt practices to optimize the use of available moisture. Trap snow to fill dugouts and replenish water tables. Dam runoff to create water reservoirs for livestock needs, as well as for possible irrigation. Ability to irrigate can markedly extend the grazing season, especially in a dry season.

6) Rapid rotational grazing (10 fields, to allow good recovery of grazed species) has been found to extend the grazing season at Melfort by from 4-10 days, compared to a less frequent (5 field) grazing system.

7) Attempting to stockpile spring production for later use. Possible species include cicer milkvetch, bluegrass-fescue fields, meadow bromegrass and 'Rebound' smooth bromegrass. This technique requires further development. Delaying utilization of forages reduces feeding value, hinders regrowth and

may cause losses due to trampling. Where practical, excess forage should be harvested at an appropriate stage of maturity for hay or silage.

FERTILIZING PASTURES

INTRODUCTION

The benefits of fertilizing pasture include increased forage production, increased nutritive value, an increased stocking rate or earlier grazing. As both nitrogen and phosphorus have residual effects, especially after large applications, the benefits of fertilizing may not be fully realized in one year, particularly a dry year. Soil testing is recommended before applying fertilizer in order that the optimum rate of N, P, S and K be maintained.

Native pasture

Fertilizing native grass pastures is generally not recommended because the response is usually small.

Grass

Grass stands respond very well to nitrogen applications. In a trial at the Termuende Research Station total forage production has increased by 43% with applications of 100 to 200 kg N/ha. Similarly crude protein yield has shown improvements of 158% compared with no fertilizer application. Grasses will also respond to phosphorus, potassium and sulphur depending upon their levels in the soil. At Melfort, application of 90 kg N and 45 kg P_2O_5/ha doubled yields of brome-alfalfa. (See subsequent sections for further details.)

Legumes

As legumes are capable of fixing nitrogen from the atmosphere, the major requirement is phosphorus. The addition of nitrogen merely replaces the nitrogen fixing capabilities. Phosphorus should be applied at seeding and every 3 to 5 years at rates of 70 to 100 kg P_2O_5/ha. Legumes will also respond to applications of sulphur and potassium depending on soil nutrient levels.

Grass/legume mixtures

Management of a grass-legume stand requires nitrogen fertilizer at a level to optimize yields while not reducing the legume content. The legume component can benefit by maintaining soil phosphorus status with an annual or

occasional application of P fertilizer and an annual moderate application of N (20-40 kg/ha), depending on the proportion of legume. Other nutrients should be added according to soil requirements.

Annuals

Following recommended fertilizer levels for grain crops in the particular area should provide an adequate supply of soil nutrients, though these pastures could benefit from additional nitrogen applied after the first or second grazing when a rotational grazing system is used.

Application method

Generally, broadcasting granular fertilizer on established stands provides the most consistent results with current methods. Research is now expanding on different methods of banding fertilizer with minimal disruption of the stand. This would be a benefit as nitrogen (especially urea) can be lost through volatilization in hot dry weather and phosphorus does not readily move through the soil to the root zone.

Some cautions

Fertilization with high levels of nitrogen can lead to excessive nitrate accumulation and create metabolic upsets in the grazing animal. The tendency for grasses to accumulate nitrate varies considerably among species and is affected by the type of fertilizer used. Urea results in lower accumulations than do nitrate containing fertilizers. The risk of nitrate accumulation is higher in annuals than perennials and is increased if pasture growth is retarded by frost or drought.

Fertilization with nitrogen at levels above 70 kg N/ha can increase the ratio of potassium to calcium plus magnesium (K:Ca + Mg). It has been suggested that if this ratio exceeds 2:1 the risk of grass tetany is increased. This risk is greatest early in the grazing season and declines with advancing plant maturity. This risk is further exacerbated by high protein levels early in the season following N fertilization, since high crude protein levels reduce the availability of Mg to cattle.

Residual effects of applying fertilizers to pastures

Both nitrogen and phosphorus have been shown to have residual effects in the soil. At the Terwuende Research Station pastures that were fertilized annually, at 100 to 200 kg/ha from 1983 to 1986 (Fig. 5), still had residual soil nitrogen in 1989 (Figs. 6 and 7). Economic analyses in 1988 indicated that a return of $2.35 was realized for every $1.00 invested in fertilizer. Other researchers in central and southern Saskatchewan have found residual

soil phosphorus still available for plant use 10 years after application. The P tends to remain in the 0-15 cm depth while N may leach below this depth, especially in light textured soils, though this did not occur at Termuende on a sandy loam Oxbow black soil.

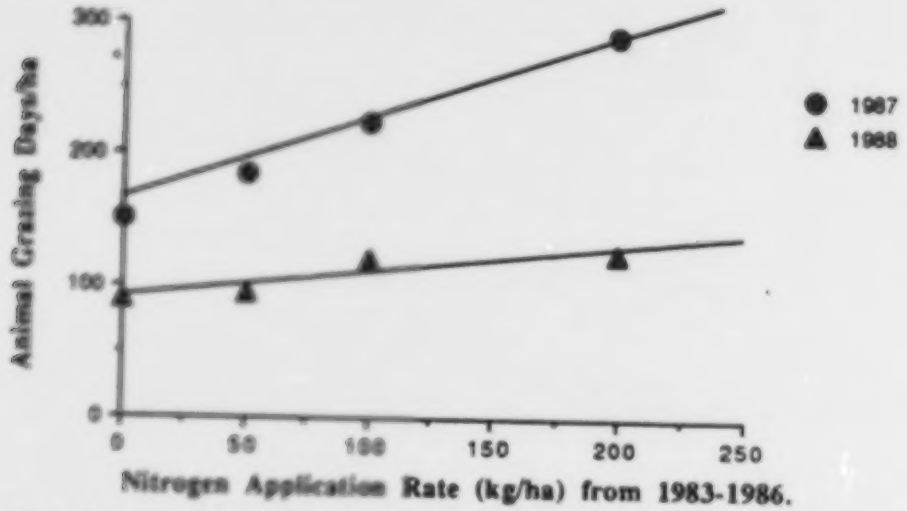


Fig. 5. Residual effects of nitrogen fertilizer applied in April each year from 1983-1986 on carrying capacity in animal grazing days per ha in both 1987 and 1988.

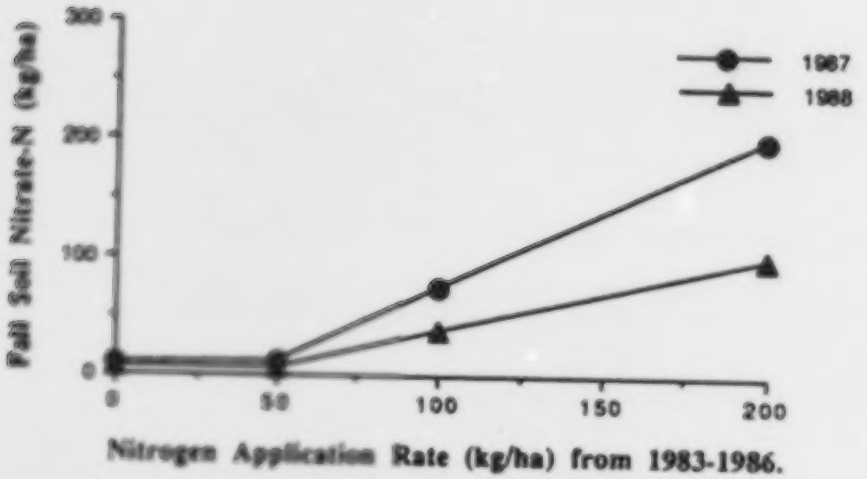


Fig. 6. Residual effects of nitrogen fertilizer applied in April each year from 1983-1986 on soil Nitrate-N in fall of 1987 and 1988.

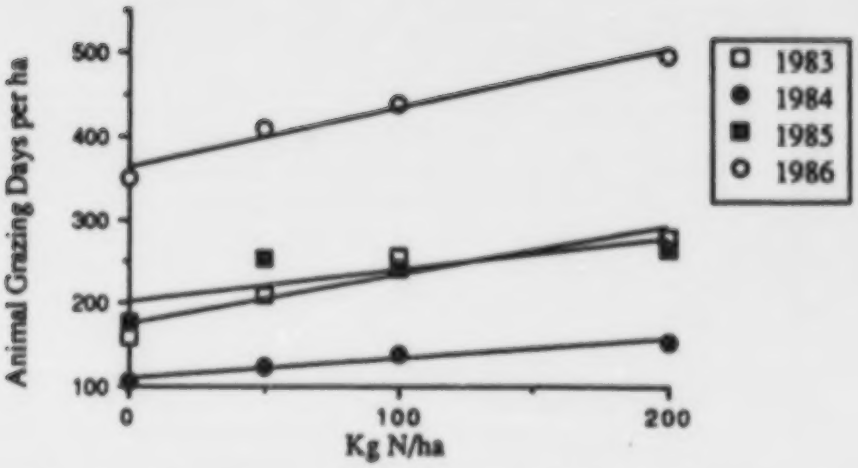


Fig. 7. The effect of nitrogen fertilizer application on animal grazing days.

Because of the residual properties, the economic benefit from fertilizer application can go well beyond the initial year. Therefore, the potential exists to "bank" fertility when cash is available for purchasing fertilizer and to draw upon those reserves during periods when cash may be short.

The wisdom (economics) of applying large amounts of fertilizer every few years will depend on the soil type, amount of rainfall (leaching), yield of the crop, trend in fertilizer prices, interest rates (on fertilizer investment), the income situation on an individual farm, and the cost of operating fertilizer spreading equipment over the terrain involved.

FERTILIZING BROMEGRASS-ALFALFA PASTURE ON A PRODUCTIVE SILTY CLAY LOAM SOIL

During the final four years of a seven year grazing trial on bromegrass-alfalfa pastures on a productive silty clay loam at Melfort 0, 45, 90, 135 and 180 kg N/ha, and 0 or 45 kg P_2O_5/ha were applied annually. In the following two years the residual effect of these treatments was measured. The results are summarized in Table 8.

Table 8. Effect on pasture dry matter yield of applying fertilizer to bromegrass-alfalfa (increased yields over control, kg/ha)

	P_2O_5	Nitrogen (kg/ha)				
		0	45	90	135	180
Av. per year (4 years)	0	(2387)*	676	1017	1241	1417
	45	730	1505	2034	2013	2376
Carryover effect (Av. 2 years)	0	(3391)*	-65	32	245	656
	45	452	148	106	374	752

*Yield of unfertilized check.

COMMENTS

1. It is highly likely that the carryover effect of the two highest levels of N fertilizer would persist for at least another year.

2. The economics of fertilizer use is summarized in the folloving table, assuming N @ 53¢/kg, P_2O_5 @ 60¢/kg, forage dry matter @ 5.5¢/kg, dry matter required per unit of animal gain @ 12, and liveweight gain valued @ $2/kg.

The value of the extra dry matter produced exceeded the cost of the fertilizer (just barely, at the two highest levels of N, without P_2O_5) for all fertilizer treatments and to a much greater extent when the nitrogen was applied with 45 kg P_2O_5/ha, over the six years of the test.

The return per dollar invested in fertilizer ranged from $3.05 to $5.90 when expressed in terms of the value of the extra liveweight gain, assuming one unit gain per 12 units of extra dry matter produced. At the end of the sixth year, return on investment was highest at the lower levels of N application, but the length of the residual effect of the higher levels of N is not known (Table 9).

Table 9. Value of additional liveweight gain per dollar invested in fertilizer on bromegrass-alfalfa pasture

	Nitrogen (kg/ha)				
	0	45	90	135	180
P_2O_5: 0					
Total fertilizer cost ($)	0	95	191	286	382
Value of extra DM ($)	0	142	227	298	384
Value of liveweight gain ($)	0	429	689	902	1163
Value of liveweight gain/fert. ($)	0	4.52	3.61	3.15	3.05
P_2O_5: 45					
Total fertilizer cost ($)	108	203	299	394	490
Value of extra DM ($)	210	347	459	484	605
Value of liveweight gain ($)	637	1053	1391	1467	1835
Value of liveweight gain/fert. ($)	5.90	5.19	4.65	3.72	3.74

RESPONSE OF BROMEGRASS-ALFALFA, RUSSIAN WILD RYE AND MIXED PASTURE STAND TO FERTILIZER APPLICATIONS ON A GRAY WOODED (WAITVILLE LOAM) SOIL AT PATHLOV

Over an 11 year period, nitrogen, phosphorus and sulphur fertilizer treatments were applied to three different pasture communities growing on Gray Wooded soil. The results are summarized in Table 10.

Table 10. Yields of pasture dry matter on a Gray-Wooded soil at the Pathlov pasture project (tonnes/ha)

Fertilizer Treatment (kg/ha)			Cost**/ha	Pasture Species		
N	P_2O_5	S	$/yr	Brome-grass (some alfalfa) (1978-88)	Russian wild rye (plus other grasses) (1977-88)	Mixed stand (original) (creeping red fescue, smooth bromegrass & Kentucky bluegrass) (1976-88)
0	0	0	0	1.64	1.79	0.79
45	0	0	24	2.44	2.31	1.14
90	0	0	48	2.33	2.26	1.28
11	45	0	33	2.10	2.11	1.00
45	45	0	51	3.20	2.92	1.82
90	45	0	75	3.24	3.17	2.03
180*	180	0	51	2.82		1.69
90	45	22	84	3.90		
90	45	45	93	3.92		

*Applied every fourth year.
**N @ 53¢/kg, P_2O_5 @ 60¢/kg, and S @ 40¢/kg (to nearest dollar).

ECONOMICS

Assuming that pasture dry matter is worth 5.5¢/kg ($50/ton) and that a kg of liveweight gain is obtained from 12 kg of dry matter and is worth $2, the value of the added dry matter and its liveweight equivalent are as follows (Table 11).

Table 11. Value of additional dry matter and liveweight gain due to fertilizer use

Fertilizer treatment (N:P:K:S)	Fert. cost $/ha	Value of Extra DM and Liveweight Gain ($/ha)					
		Bromegrass		Russian wild rye		Mixed Stand	
		DM	Livevt. gain	DM	Livevt. gain	DM	Livevt. gain
45:0:0:0	24	44	133	29	87	19	58
90:0:0:0	48	38	115	26	78	29	82
11:45:0:0	33	25	77	18	53	12	35
45:45:0:0	51	86	260	62	188	57	172
90:45:0:0	75	88	267	76	230	68	207
180:180:0:0/4	51	65	197			50	150
90:45:0:22	84	124	377				
90:45:0:45	93	125	380				

1. An investment of one dollar in fertilizer returned from 36¢ to $1.83 (av. $1.03) over the treatments tested when based on dry matter valued at 5.5¢/kg. The return per dollar invested ranged from $1.06 to $5.54 (av. $3.12) when based on the value of extra liveweight gain.

2. Under conditions at Pathlov, the most economical response has occurred when 90 kg N and 45 kg P/ha has been applied. On the bromegrass pasture (with some alfalfa) the addition of 22 kg S per ha vas economically advantageous.

EFFECT OF ROV SPACINGS ON YIELD

Forage crops produce at optimum levels when groving conditions permit individual plants to attain their growth potential. As a result, it has been demonstrated that seeding forage crops in rovs, spaced to permit adequate moisture and nutrient supplies, will result in much better dry matter production than if seed is broadcast or otherwise seeded to create a high level of inter-plant competition.

The optimum space between rows depends on the expected moisture supply, with recommended spaces varying from 15 cm (6") in irrigated areas, up to 90 cm (36") in very dry areas. In most of the Aspen Parkland (Black and Gray-Wooded soil zones) spacings should be about 30 cm (12").

Although at Swift Current (in the Brown soil zone) wide row spacings increased yield, wide row spacings in the Aspen Parkbelt depress yields, lead to weed problems, and increase the possibility of inter-row wind and water erosion. However, spacing crested wheatgrass rows at 50 cm, provided earlier grazing in part because the more grass was concentrated in a smaller area and was therefore more efficiently grazed by the animals. Weeds did not invade between the wide rows but overall production was not increased.

GRAZING MANAGEMENT

INTRODUCTION

Prairie and parkland grasslands evolved with grazing pressure from wild ungulates. Although large game herds vanished with settlement and large scale land breaking, these rangelands and tame pasture still support substantial and diverse wildlife populations and a large cattle herd.

The Aspen parkland is a transitional zone between the southern grasslands and the northern Boreal forest. It is of fairly recent origin and became significant only as widespread settlement led to suppression of fires. Prior to settlement, wildfires periodically burned these areas, keeping aspen groves restricted to only the moister sites.

Today, the aspen parkland spreads as a broad band from Manitoba to Alberta. Although much of this areas has been cleared for grain farming, substantial areas have remained in native cover due to stoniness, uneven topography, poor drainage, low inherent productivity, or coarse soil texture. Tame pastures have been carved out of heavy aspen forest throughout much of this region, and some former grain land, mainly on unproductive or difficult-to-work soil, has also been converted to tame pasture.

Forage is an important crop throughout the aspen parkland, and contributes considerably to the farm economy. The gray wooded soils of this region are best suited to growing of forage, and show substantial improvement in structure and organic matter when supporting forages, particularly perennial legumes. The climate of this region also makes forage a viable crop for grazing, seed and feed. The short growing season, and precipitation patterns often make this form of cropping the most logical.

Livestock behavior

Controlling livestock behavior is a great challenge in pasture management.

Forage preference is learned and, as a result, cattle are highly selective in their feeding, exhibiting a strong preference for green leaves over stems and dead forage.

Given the opportunity, livestock will regraze individual plants or one species within a mixture of species, several times during the growing season. This regrazing without a recovery period, weakens the forage plant and may eliminate it from the stand.

Cattle are reluctant to graze on slopes exceeding 15 percent and, in rolling terrain, will rarely feed at elevations greater than 70 m above water. They are also limited by horizontal distance from water. Livestock will seek shade during hot periods of the summer, resulting in a disproportionally high usage of treed and streamside areas.

Pasture improvements and grazing systems help to control livestock behavior. Fencing, salting, fertilizing, herding, and water development lead to more uniform livestock distribution. Rest-rotation, deferred-rotation, and short-duration grazing systems are designed to control timing, intensity and frequency of grazing on individual plants. The physiological needs of both the grazing animal and the forge plants must receive serious consideration.

Plant response to grazing

Seasonal carbohydrate storage

Non-structural carbohydrates (sugars and starches) are used as energy for plant growth and respiration. Carbohydrate reserves are necessary for winter survival, early spring growth and regrowth after defoliation. The majority of non-structural carbohydrates is stored in stem bases, stolons, rhizomes, corms and roots. In order for non-structural carbohydrates to accumulate, photosynthetic production must exceed respiration demands. Defoliation removes photosynthetic tissue, causing the ratio of photosynthesis/respiration to change. Stored energy must therefore be used to initiate regrowth. Defoliation which removes only some tillers from a plant, while leaving others, is less detrimental because non-structural carbohydrates may be transferred from ungrazed to grazed tillers.

Carbohydrate levels follow the seasonal pattern, as depicted in Fig. 8, with a low occurring at the 2 to 4 leaf stage, and maximum storage occurring at the seed ripe stage. Grazing which is too early, too severe, or at the wrong phenological stage weakens plants. Successful grazing systems take these factors into account. For example, bromegrass and timothy are susceptible to grazing during stem elongation, while crested wheatgrass is less susceptible.

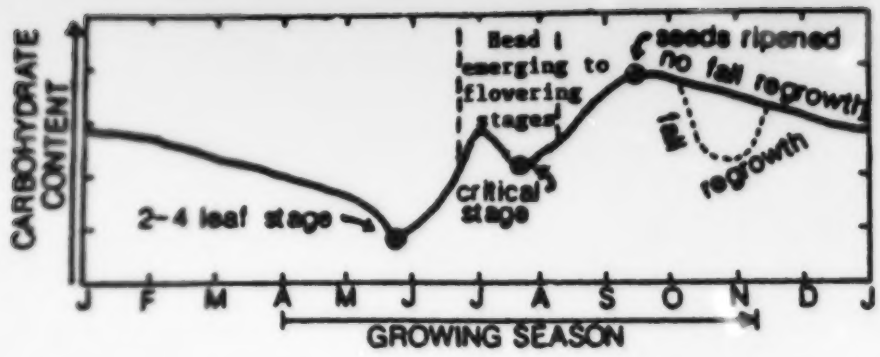


Fig. 8. Seasonal trend in carbohydrate storage in forage plants.

Root growth

Root growth has been shown to stop within 24 hours of severe defoliation. If soil moisture conditions are unfavorable, root growth may not resume until the following year. This places the forage plant at a competitive disadvantage in the sward. In general terms, grazing which leaves 50 per cent of leaf area will minimize the period when roots do not grow.

Grazing management systems

A grazing system can be defined as the manipulation of livestock grazing in a planned manner in order to accomplish a desired goal. Systems may be simple, as in season long continuous-use, or complicated as in those requiring high stocking density and rapid movement of livestock from one pasture to the next in a planned rotation. Grazing systems are designed to control timing, intensity and frequency of grazing on individual plants and improve livestock distribution.

In order for a grazing system to be successful in the long term, it must do the following:

1. Balance livestock numbers to forage supply.

2. Distribute livestock uniformly over the pasture, and reduce selective grazing.

3. Alternate periods of grazing and periods of rest. These periods of rest must occur during times of active growth in order to be effective (Fig. 9).

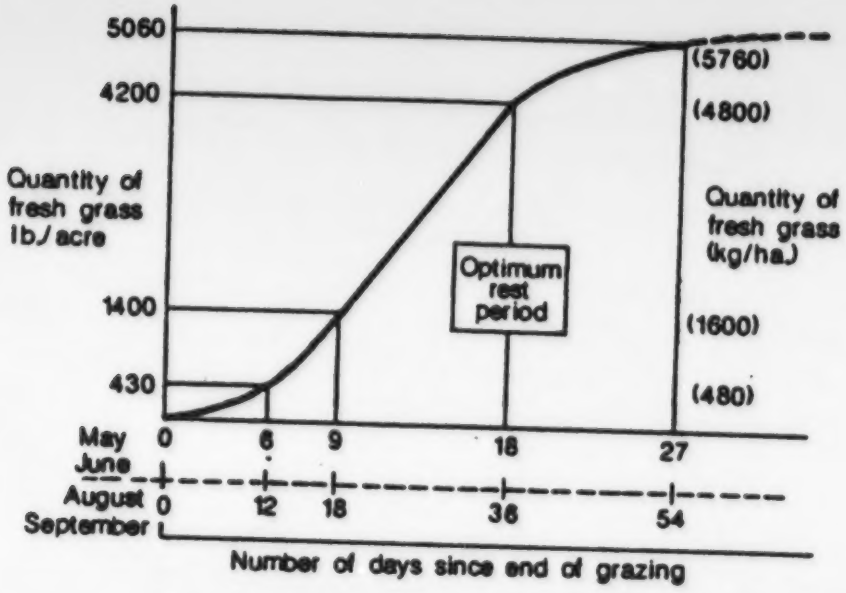


Fig. 9. Effect of rest period on the production of pasture herbage (example only, actual values will depend on forage species and growing conditions).

4. Maintain a healthy plant community with a desirable distribution of species and age classes. Allow as little damage as possible to plants when they are most susceptible to grazing damage.

5. Maintain environmentally healthy watershed and soil.

6. Meet nutritional requirements of the animals.

7. Optimize livestock gain per acre.

8. Be sound economically, practical to implement, reasonable to operate, and with the flexibility to adjust to wide variations in pasture supply.

Relationship between stock density and beef production

Individual gain is maximized when animals are allowed to graze selectively at low stocking rates and densities. As stock density and stocking rate increase, individual performance declines (due to declining quality/quantity of herbage), but overall beef production per unit of land will increase to a point, due to the increased number of animals, even though gain per animal is less. Overall production will decline as a pasture

becomes overstocked and overgrazed (Fig. 10).

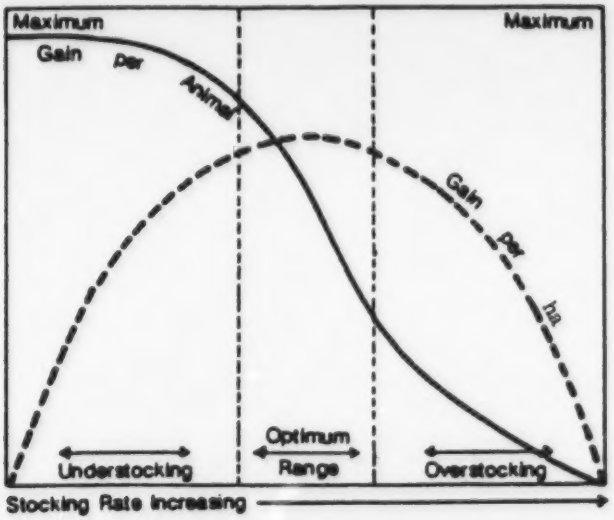


Fig. 10. Effect of stocking rate on gain per animal and per hectare.

The great challenge in range management, therefore, is to optimize livestock production through correct stocking rates and levels of utilization.

TYPES OF GRAZING SYSTEMS

Continuous grazing

Cattle are placed on one pasture area and remain there throughout the grazing period. Management consists of adding or removing cattle to balance numbers with the available herbage and of enticing cattle to undergrazed areas by providing water, salt, shade, fly control equipment or creep feeding in those areas. Provision of supplementary grazing (usually cereals such as spring seeded oats, winter wheat and fall rye) or the feeding of silage, soilage, hay or grain on pastures can be employed to maintain livestock numbers.

Advantages

- The system is simple to manage.

- Fencing and watering costs are relatively low per unit of pasture.

Disadvantages

- There is little or no control over the grazing of individual species with the result that the more palatable species may be quickly grazed out. Lack of a rest (recovery) period accentuates the problem.

- In an undergrazing situation, grazing of a species may become uneven, with cattle preferring to graze regrowth rather than graze material that has matured (e.g. crested wheatgrass becomes quite unpalatable to grazing cattle once it has headed out). This results in inefficient utilization of the pasture.

- It is usually impractical to harvest surplus pasture as hay or silage due to the partially and unevenly grazed condition of the stand. Adding more cattle may not be economical (or possible) under some situations.

- It is more difficult to inspect cattle and to remove cattle for veterinary treatment.

Rotational grazing

A pasture management system in which the area is divided into at least two, but preferably four or more fields, with cattle being confined to one field at a time and moved to the next frequently enough to permit utilization of each species at a near optimum stage of maturity. (See example models at end of this publication.)

Advantages

- Individual fields can be seeded to specific forage species with different seasonal growth patterns and grazed at the most appropriate time for that species (e.g. crested wheatgrass for early grazing) and/or at the right time to assure optimum intake of pasture of quality appropriate to the class of grazing animal. This technique helps to even out the production of herbage over a longer grazing period.

- Specific forage species can be grown on different soil types where they are best suited, and can be utilized at the optimum stage of maturity (i.e. tall wheatgrass on saline areas, reed canarygrass on flooded areas, etc.). This helps to increase overall production compared to the use of one species or mixture of species over the whole rotation.

- Forage species experience periodic rest periods during which time they can build up root reserves, set seed, etc..

- Each field (species) can be grazed uniformly to optimum height, permitting a uniform recovery for the next grazing period and possibly better brush control where that is a problem.

- In good years, some fields can be harvested for hay or silage, much more efficiently than if the whole area was under-grazed.

- Individual pastures can be treated for weed control, irrigated, fertilized, or droppings spread, while cattle are absent from that field.

- Individual fields can be worked down and reseeded as required, to assure an ongoing rejuvenation program without major disruption of the pasture resource.

- Cattle can be more easily inspected, treated, etc., if confined to one field rather than spread over the whole pasture.

Disadvantages

- The cost of fencing, and perhaps water facilities, is increased.

- Greater attention to both cattle and pastures is required to prevent overgrazing of pastures and underfeeding of cattle.

- Cattle may suffer more fly annoyance if in more compact herds or if shade or shelter from flies isn't available on all paddocks.

Other types of rotational grazing

There are many variations of rotational grazing systems, from those involving three of four paddocks or fields to those involving ten or more paddocks, and from those involving only one forage species or mixture of species to those involving several different species or mixtures. Ideally the goal is to graze the pasture species quickly to a minimum acceptable height and to then move to the next pasture, allowing the plants to regrow over a period sufficiently long that they will recover, replenish root reserves, etc., before being regrazed. If, for example, it takes a particular species 5 weeks to recover (and this will depend on growing conditions and the species involved) and there are six paddocks available then cattle would have to be moved, on average, every six days. The more rapid the rotation (i.e. the more fields, the greater is the "intensity" of the grazing management system. In all cases the pasture manager must closely monitor all fields in the system and closely control the timing of grazing on any one pasture, and the order in which pastures are grazed, for optimum overall productivity.

Strip grazing

Cattle, normally dairy cows, are allowed access to just enough pasture to meet their requirements for a day or half a day and then moved to a fresh strip. Areas are controlled by portable (usually electric) fencing units.

Advantages

- This system permits highly controlled grazing, a maximum recovery period for the pasture, and intensive management (spreading of droppings, application of fertilizer, irrigation, etc.).

- It can be used to allow high producing cows to selectively graze the pastures and then use dry cows, replacement heifers, etc., access to the strip to "clean-up" the remaining herbage.

- The system minimizes the physical activity of the cows and facilities "rounding up" for milking.

Disadvantages

- A considerable amount of labor and management is required to be certain that the cows' needs are met without under-utilizing the herbage available.

Zero (mechanical grazing)

Fields which might normally be used for grazing are instead harvested mechanically (using a swather and forage harvester or a direct cut forage harvester) and the chopped feed hauled to the cattle, either on depleted pasture or in drylot.

Advantages

- There is no wastage due to trampling or fouling.

- There is no requirement for fencing and water facilities.

- Complete consumption of the harvested material results in greater livestock productivity per unit of land.

- In the case of a dairy operation, this system facilitates the use of fields some distance from the barn thus eliminating the need to move cattle to and from pasture.

Disadvantages

- Unless different fields are seeded in succession over a period of time, as could be the case with annual forage crops such as oat, the crop becomes progressively more mature and decreases in feeding value. Careful planning is thus required to assure, within reasonable limits, a consistent quality of feed.

- Additional labor, equipment and operating costs are required. Fields, feedlots and roadways must be capable of accommodating wheeled traffic and

heavy loads during wet weather.

- Manure, which in a pasture situation would be deposited in the field, must be handled by some other means.

- Lower rates of gain may be experienced because the animal is forced to eat the whole plant rather than selected portions of it.

Comments

For short term situations, this practice may be satisfactory. However, if provision of this type of feed was to become a planned long-term component of the livestock system, it would be much more efficient to harvest the material as hay, haylage or silage.

Other grazing systems

In this publication we have included information on, and examples of, grazing management systems that are applicable to the Aspen parkland and primarily those involving cultivated, as contrasted to native pastures. In contrast to the southern part of the prairie provinces, the Aspen parkland contains relatively little native pasture. In general, native pastures are less productive and have a greater variety of species than do cultivated pastures. There is less economic justification for investment in fences, water systems, weed and brush control and consequently grazing systems are simple, usually involving, at most, two or three pastures in the system. Under these conditions grazing systems such as "deferred", "two-paddock switchback", "deferred rotation", "rest rotation" and "complementary" are employed. These are designed to allow up to season-long rest periods so that the forage can set seed and new plants can become established, or shorter rest periods to permit desirable species to recover from selective grazing pressures. In some systems a portion of the native range is broken and reseeded to Russian wild rye or crested wheatgrass which are grazed prior to the native range, thus extending the grazing season as well as increasing overall production.

OTHER PASTURE MANAGEMENT PRACTICES

Mineral supplementation

Cattle grazing good pasture (including a legume) normally receive adequate amounts of calcium but require supplemental phosphorus in addition to cobalt-iodized (blue) salt. It is recommended that cattle have access to both block salt and a granular mineral mix made up of one part cobalt-iodized trace mineralized salt and two parts of a high phosphorus calcium phosphate (18% Ca, 20.5% P). The granular mineral mix should be limit-fed initially, until appetite is satisfied and then self-fed. Check mineral boxes regularly to be sure that mineral is available and is not caked or contaminated.

Cows nursing calves will require from 32-46 grams of calcium and 26-34 grams of phosphorus daily. In the early part of the pasture season phosphorus can make up about 0.16-0.25% of the dry matter while at the end of the pasture season the amount can drop to less than half that value. This means that cows would have to eat about 15 kg of early spring pasture dry matter and 30 kg of late summer pasture dry matter to meet their phosphorus requirements. Obviously a deficiency is inevitable when grazing anything but early, palatable, nutritious pasture, unless a supplement is provided!

The trace mineral content of pastures at various locations in northeastern Saskatchewan were determined over a three year period. The results for 1980 are summarized in Table 12. Four minerals, sodium, phosphorus, magnesium and copper were deficient or marginal at all sites with zinc and selenium marginal low or marginal at some sites.

Table 12. [illegible] of minerals in vegetation samples harvested from public and private pasture in Northeastern Saskatchewan

Location/soil type	No. of sites	Cut*	Mineral Concentration in Dry Matter											
			%					P.P.M.						
			Ca	P	Mg	K	S	Cu	Mn	Zn	Mo	Mo	Se
Minerotrophic (clay-loam)	7	1	0.36	0.22	0.23	3.1	0.22	6.7	57	57	21	5.3	0.21
	7	2	0.84	0.21	0.23	1.5	0.20	6.3	102	218	52	7.1	0.20
Ombrotrophic (sandy-loam)	5	1	0.73	0.26	0.22	1.8	0.26	5.7	75	100	34	2.8	0.22
	5	2	0.80	0.15	0.19	0.9	0.17	4.1	118	225	40	3.0	0.19
Plateau-upland (loam)	13	1	1.08	0.19	0.23	2.4	0.23	6.5	53	96	35	6.8	0.40
	13	2	1.12	0.14	0.20	1.4	0.20	5.3	70	165	33	7.9	0.32
Foothills (loam)	9	1	0.92	0.22	0.20	2.3	0.17	6.5	63	25	23	5.1	0.38
	9	2	0.68	0.20	0.15	2.2	0.18	5.0	69	20	23	4.7	0.28
Peatlands (loam)	9	1	0.81	0.19	0.25	2.3	0.22	7.0	61	91	35	5.8	0.40
	9	2	1.38	0.14	0.23	1.2	0.23	6.2	77	187	37	7.7	0.31
Amount required by various classes of beef cattle			0.14-0.82	0.14-0.40	0.13-0.30	0.6-0.8	0.1	6-10	20	30-40	2000	40.01	0.1-0.3

*Cut 1: Mid to late July; Cut 2: late September to October.

Note: Ca = Calcium; P = Phosphorus; Mg = Magnesium; K = Potassium; S = Sulphur; Cu = Copper; Mn = Manganese; Zn = Zinc; Mo = Molybdenum; Se = Selenium

Low copper levels (4-7 ppm) compared to a requirement of 6-10 ppm may be aggravated by high molybdenum intake, which interferes with the absorption and utilization of copper. Molybdenum levels above 5.0 ppm and molybdenum:copper ratios greater than 0.5 are considered excessive. In this study molybdenum levels ranged from 2.8-7.9 ppm and molybdenum:copper ratios ranged from 0.15-1.3.

Where animal performance is below expected levels, for no apparent

reason, mineral deficiencies or imbalances should be suspected and pasture herbage analysed for some of the more common trace minerals. Sodium, calcium and phosphorus are normally supplied free choice in the form of block salt and mineral mixtures. Other elements may also be included in the mineral mix if found to be deficient in the herbage.

Growth stimulating implants

Implants such as Synovex S (200 mg progesterone + 20 mg estradiol benzoate) for steers, Synovex H (200 mg testosterone + 20 mg estradiol benzoate) for heifers, and Ralgro (36 mg resorcyclic acid) for both steers and heifers are widely used for finishing cattle in feedlots and can be equally effective when used for growing-finishing cattle on productive pastures. Calves can be implanted with Synovex S (100 mg progesterone + 10 mg estradiol benzoate) any time from 45 days of age until weaning. Do not implant heifers to be retained for breeding. Increased rate of gain on pasture normally varies between 0.10 and 0.25 kg per head per day. (Cost around $1.75/head.) If using Ralgro, do not market within 65 days of implanting.

Fly control on pasture

Protection of grazing cattle from insect pests can save considerable economic losses both in reduced efficiency of animal production and in death losses. Beef cattle should be treated with a systemic insecticide in the fall for the control of warble flies. Black flies can cause severe annoyance, and even death of cattle. Controlling the insect in fast running rivers and streams has been effective, but must be carried out by professionals only. Cattle can find relief from these and other insects in the bush or in semi-darkened sheds, barns, etc..

The value of an insecticide/repellent eartag (Bovaid-Shell Chemicals Ltd.) for heifers on pasture was assessed during a 95 day (June 19-Sept. 22) grazing season. The results are summarized in Table 13.

Table 13. Effect of bovaid ear tags on heifer gains on pasture

Treatment	Breed	Average initial weight	Weight off pasture	Average gain/hd	Average daily gain
		kg			
Tagged (2 tags, one in each ear)	AxH	395	468	73	0.76
	SxH	430	506	76	0.80
Controls (no tags)	AxH	403	458	55	0.57
	SxH	437	501	65	0.68

In cooperation with Dr. Jim Jovsey and Mr. Jim Armstrong, Saskatchevan Agriculture; and Dr. Hartley Freeden, Agriculture Canada Research Station, Saskatoon.

The experiment was designed to determine the effectiveness of the ear tags against blackflies. However, few blackflies, but large numbers of horn flies were present on the control heifers with few, if any, on the tagged heifers. With livestock gains valued at $1.75/kg and the cost of the tags @ $3 each, a dollar invested in ear tags returned about $4.25. The response of the dark colored cattle (Angus x Hereford) to the eartags was slightly better than that of the lighter colored cattle (Simmental x Hereford).

An Alberta study found that the use of this kind of eartag on yearling Hereford steers resulted in an extra 22 kg of gain over a 115 day pasture season, while the forced use of insecticide impregnated backrubbers (to and from water supply) reduced black flies and mosquitoes by 40 and 60%, respectively.

Herd health

Generally, calves should be vaccinated for diseases such as blackleg and malignant edema prior to being placed on pasture and again before weaning. A the time of the booster shot, calves may be vaccinated for bovine rhinotrocheitis (IBR) on the advice of a veterinarian. Heifer calves kept fo breeding replacements, should be vaccinated for bovine virus diarrhea (BVD) two to three weeks after weaning. A veterinarian should be consulted when developing a disease prevention program.

EFFECT OF VINTERING PLANE OF NUTRITION ON STEER GAINS ON PASTURE

It is well known that restricting the rate of gain of groving beef cattle (within limits) will result in increased rate of gain when the cattle are subsequently placed on full feed either in the feedlot or on pasture. During a three year period at Melfort, vintering beef calves were fed rations of identical composition but limited in amounts to support three different rates of gain, 0.23, 0.45 and 0.68 kg/hd/day (0.5, 1.0 and 1.5 pounds/day). The purpose of the trial was to determine the effect of this practice not only on the efficiency of winter gains but on the performance on pasture the following summer. Half of the calves vintered to gain at each of the three rates were implanted when placed on pasture. The effect of both rate of winter gain and of implanting is shown in Figure 11, while the effect of rate of winter gain on feed conversion efficiency during the winter is shown in Figure 12. The results of this project and an estimate of the effect of this system of management on the overall economics of carrying the cattle to market weight and condition are shown in Table 14.

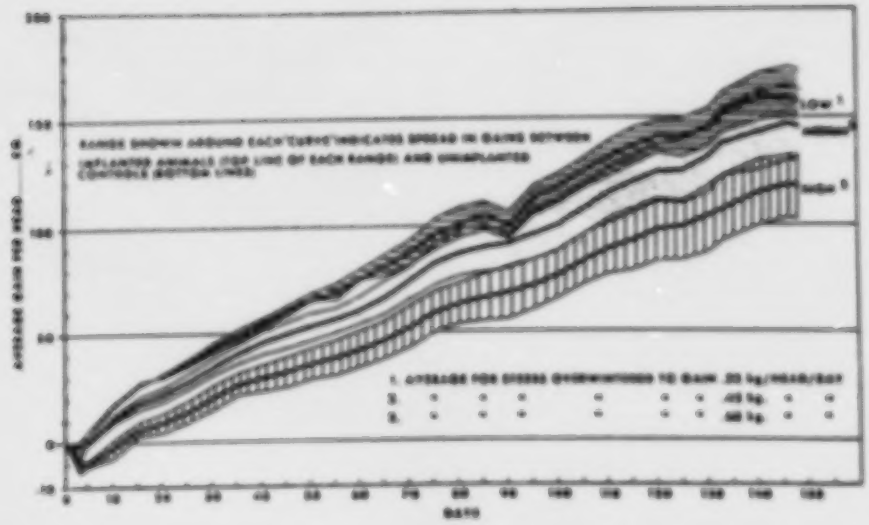


Fig. 11. Effect of rate of winter gain on subsequent steer gains on pasture

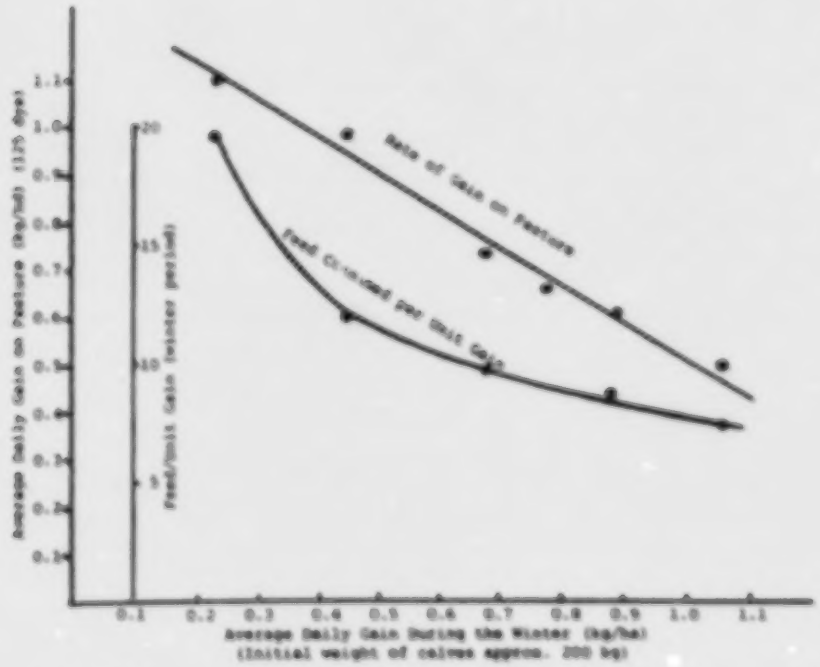

Rate of Gain on Pasture
Feed Consumed per Unit Gain
Feed/Unit Gain (winter period)
Average Daily Gain on Pasture (kg/hd) (12% dye)
Average Daily Gain During the Winter (kg/ha)
(Initial weight of calves approx. 200 kg)

Fig. 12. Effect of growth rate of steer calves during the winter on feed:gain ratio and on subsequent rate of gain on pasture

Table 14. Effect of pre-pasture rate of gain on economics of finishing cattle (average of three years)

	Pre-pasture (winter) rate of gain (kg/hd/day)		
	0.23	0.45	0.68
Winter Phase (189 days)			
Av. initial wt. (kg)	211	211	214
Initial cost @ $2.60/kg	548.60	548.60	556.40
Av. daily gain (kg)	0.22	0.45	0.68
Total gain (kg)	42	86	128
Av. total winter feed/hd (kg)			
- hay @ $66/tonne	621	794	966
- grain @ $110/tonne	138	177	219
- supplement @ $200/tonne	29	39	51
Cost of winter feed/kg gain ($)	1.48	0.89	0.77
Total cost of winter feed ($)	61.97	76.58	98.05
Pasture Phase (133 days)			
Av. weight on pasture (kg)	254	297	342
Av. daily gain (kg)	1.12	1.00	0.79
Estimated cost of pasture/hd ($)			
- @ $44/tonne, 60% TDN	45.85	53.64	56.58
Av. weight off pasture (kg)	402	430	447
Feedlot Phase (estimated)			
Assumed average daily gain (kg)	1.4	1.3	1.2
Assumed days on feed	70	54	44
Est. feed:gain ratio	7.0	7.3	7.6
Est. feed cost @ 9.6¢/kg ($)	65.86	49.06	38.67
Assumed final wt. (kg)	500	500	500
Est. market value @ $1.87/kg	935.00	935.00	935.00
Est. shipping, veterinary, implant and pasture mineral/hd ($)	21.00	21.00	21.00
Est. interest on investment @ 10%	58.92	56.51	55.79
Est. drylot charge @ 15¢/hd/day	38.85	36.45	34.95
Total feed and pasture ($/hd)	173.68	179.28	193.30
Difference: returns to labor, overhead, etc. ($)	93.95	93.16	73.56
Total feeder & production costs ($/hd)	841.05	841.84	861.44

Comments

1. Even with the shorter than normal winter feeding period and the longer than normal grazing season (due to use of oat pastures), the economics of restricting rate of gain of growing calves prior to the grazing season in

order to increase gains on pasture is questionable and could easily shift either way depending on the relative values placed on feeds vs pastures. If our assumptions (based on feeding standards and results of related feedlot studies) are close to being correct, there was no advantage in restricting rate of winter gain to less than 0.45 (1 lb.) per head per day, although increasing rate of winter gain from 0.45 to 0.68 kg/hd/day reduced returns to labor and other production costs by an estimated $20/head.

2. These tests were carried out using steers of Hereford breeding. If the test had been carried out with "exotic" crossbred cattle it is more than likely that the results would have been quite different because of their rangier type and tendency to finish at considerably heavier weights.

3. The concluding point is that when placing groving-finishing cattle on pasture it is likely a good practice to be sure that they are in good groving condition and not carrying too much fleshing/finish. The use of a growth promoting implant will stimulate growth rather than fattening and result in more efficient feed (pasture) conversion to liveweight gain, and heavier weights at finish (see Fig. 10).

It is interesting to estimate TDN required on pasture by cattle differing in weight, using information in published tables of nutrient requirements. Table 15 shows the estimated TDN requirements for steers on pasture.

Table 15. Estimated TDN requirements of steers on pasture

Rate of winter gain (kg) (200 days)	Wt. on pasture (kg)	Gain on pasture (kg) (120 days)	Wt. off pasture (kg)	TDN req'd/ gain (kg)		TDN for maintenance activity level (25%)		Total TDN req'd on pasture (kg)
				/kg	Total	kg/100 kg/day	Total	
0.23	246	142	388	2.80	398	0.876	333	731
0.45	290	122	412	3.01	367	0.854	360	727
0.68	336	103	439	3.23	333	0.834	388	721
0.91	382	84	466	3.44	704	0.816	415	719
1.14	428	66	494	3.72	246	0.794	439	685

This method of calculation, although only an approximation, suggests that it will require about 6% more feed for the lighter, faster gaining steers than for the heavier, slower gaining steers. Whether this fully accounts for the compensatory growth effect is not known, but if there is an additional effect, this would reduce the 6% difference.

GRAZING TRIALS WITH CATTLE AND SHEEP

A COMPARISON OF THREE PASTURE MANAGEMENT SYSTEMS ON PRODUCTIVE BLACK SOIL AT MELFORT

During a seven year period, the productivity of three pasture management systems was assessed, using yearling Hereford steers averaging about 275 kg at the start of the grazing period. The three systems were as follows:

A) Continuously grazed bromegrass-alfalfa (Br-Alf) (4, 2.4 ha paddocks)

B) Rotationally grazed bromegrass-alfalfa, crested wheatgrass-alfalfa (CWG-Alf), and Russian wild rye (RWR) (2 sets of 1.2, 0.6 and 0.6 ha paddocks, respectively).

C) As in B except that the RWR paddock was grazed only after the removal of a seed crop (2 sets of 1.2, 0.6 and 0.6 ha paddocks, respectively).

Br-Alf and CWG-Alf were seeded in rows spaced at 15 cm, and RWR at 36 cm. Fertilizer (75 kg N/ha) was applied annually to the RWR and during the last four years only, to the Br-Alf and CWG-Alf. "Put and Take" grazing management was employed.

Key results are summarized in Table 16.

Comments (Table 16)

1. The use of RWR extended the grazing season (on both ends) by about 2 weeks. However, production was no higher than on the continuously grazed bromegrass pastures. RWR would thus be more suitable for a cow-calf operation than a feeder steer operation. RWR tended to increase in production (relative to the other species) as the stand aged and is long-lived when properly established. (One of the fields was not broken in 1968 and is still productive in 1990!)

2. It is notable that the cattle grazing the crested wheatgrass-alfalfa pasture required appreciably less forage dry matter to produce a unit of gain than those grazing the other types of pastures.

3. Production would have been higher had all pastures been fertilized annually and all (instead of half) of the animals implanted.

4. Subsequent experience would suggest that good grazing management should involve at least 4 to 5 fields grazed in rotation.

Table 16. A comparison of three pasture management systems on productive Black soil (Melfort)

	Treatment A Continuously Grazed	Treatment B Rotationally Grazed Season Long			Treatment C Rotationally Grazed (RWR fall only)		
	Br-Alf*	RWR	CWG-Alf*	Br-Alf	CWG	Br-Alf	RWR**
Steer days/ha	321	368	326	326	331	301	198
Av. daily gain (kg)	1.0	0.9	1.2	1.2	1.1	1.0	0.8
Dry matter (DM/ha) (kg)	4794	3603	3759	4218	3393	3862	2183
Est. DM consumed (kg/ha)	4398	3252	3338	3868	3110	3527	1747
Total dig. nutrients (kg/ha)***	1603	1628	1784	1640	1679	1497	1045
Liveweight gain (kg/ha)	326	295	399	340	353	293	168
Kg DM/kg gain	13.5	11.0	8.4	11.4	8.8	12.0	10.4

*Alfalfa constituted 22% of Br-alf stands in first 3 years, down to 5% by 1966; and 18% of CWG-alf in 1960, 9% in 1962; eliminated in 1964.

**Seed yield averaged 410 kg/ha.

***Based on requirements for maintenance and gains of cattle.

A COMPARISON OF FOUR SYSTEMS FOR MANAGING YEARLING BEEF STEERS ON PASTURE

During a seven year period, four management systems were evaluated using yearling beef steers, under four-field rotational grazing, on a bromegrass (Carlton 9 kg seed/ha), alfalfa (Rambler 4.5 kg seed/ha) pasture. The 39 ha test pasture was divided into 12, 3 1/4 ha paddocks which were each sub-divided into 4, 0.8 ha cells. Three paddocks were assigned to each of the four management systems. In all, 12 separate herds of cattle of similar breeding, weight and condition were assigned to the 12 paddocks. Each herd comprised grazing units made up of one Hereford, one Charolais x Angus and one Angus. Half of the grazing units on each pasture were implanted with Synovex S when placed on pasture. Fertilizer was applied during the last five of the seven years (90 kg N/ha). The management treatments were as follows:

1. "Put and Take" - number of steers adjusted downward as pasture production declined.

2. Pasture & Silage - stocked at an average rate (2.5 steers/ha). Surplus pasturage removed as silage and fed back on pasture during the latter part of the season.

3. Pasture & Oat Soilage - stocked at 3.7 steers/ha with supplementary oat soilage (chopped green oats produced off station) fed on pasture once pasture production would not maintain rate of gain.

4. Pasture & Barley - stocked at 3.7 steers/ha, with rolled barley fed on pasture once pasture would not maintain rate of gain.

The rolled barley was hand-fed beginning in early July. As the quantity and quality of the pasture declined, the allowance of grain was gradually increased by about 1 kg per head daily until grain was left in the trough, at which point the grain was placed in self-feeders. Some problems with bloat arose when late summer rains caused the alfalfa component of the pasture to regrow faster than the bromegrass. If this occurs, it would be preferable to dilute the supplemented grain with ground straw (perhaps 25-40%) rather than to revert to limited hand-feeding. Feeding grain on pasture can speed the finishing of the cattle and facilitates the transition to feedlot finishing.

A quantity of standing green oats (soilage) was swathed and field-chopped daily and hauled to the appropriate pasture where it was "hand-fed" to appetite daily.

Cobalt-iodized block salt and a mineral mix consisting of one part granulated cobalt-iodized salt and two parts of a calcium phosphate (18% Ca, 20.5% P) were available free choice.

The results are summarized in Table 17.

Table 17. A comparison of pasture productivity under four steer management systems (average 7 years)

	Management System			
	1 Put & Take	2 Pasture & Silage	3 Pasture & Oat Soilage	4 Pasture & Barley
No. of steers on test	36	24	35	35
Av. initial weight (kg)	316	317	315	316
Steers at end of season	15	20	31	31
Av. grazing season (days)	105	114	111	113
Av. daily gain (kg)	1.01	1.03	1.01	1.20
Av. animal days/ha	271	275	371	365
Av. final weight (kg)	390	431	419	437
Liveweight gain/ha (kg)	274	283	375	438
Dry matter produced/ha (kg)	3818	4137	4260	4270
% DM production consumed	85	82	85	84
Supplementary DM fed/ha	0	545*	1000	1160
Days of supplemental feeding	0	37	55	75
Amount supplemental DM/hd/day (kg)	0	6.4	6.0	4.7
Total feed DM:Gain ratio	11.9	11.9	12.3	10.9
Estimated Relative Economics				
Sale of cattle @ $1.87/kg ($)	2706.68	1994.15	2827.17	2948.62
Cost of purchasing feeders @ $2/kg	2345.57	1568.66	2273.20	2280.41
Interest on feeder cost @ 10% ($)	46.75	47.70	64.08	63.49
Facility charge @ 6¢/hd/da, ($)	16.24	16.48	22.27	21.90
Cost of pasture @ $120/ha ($)	120.00	120.00	120.00	120.00
Cost of supplemental feed ($)	0.00	15.89	25.00	76.56
Salt & mineral @ 8¢/hd/day ($)	20.37	21.97	29.70	29.19
Implant @ $1.75/hd ($)	6.49	4.33	6.31	6.31
Veterinary & shipping (in & out) @ $25	92.78	61.86	90.21	90.21
Estimate return to labor ($/ha)	58.48	137.27	196.40	260.55

*Included in dry matter produced.

Assumptions:
- Cost of putting up silage $35/tonne; oat soilage $55/tonne; and barley $66/tonne (all on a dry matter basis).
- All cattle were worth $1.87/kg when removed from pasture.

Note:
- Only half of the cattle were implanted in the final year and fertilizer was applied at 90 kg/ha only during the last 5 of the 7 years involved in the test.
- Pasture tended to be understocked in the final year of the test. This led to some maturing of the pasture which depressed rate of gain, particularly in Treatments 3 & 4, and a reduced need to provide supplemental feed for these two treatments.
- Results are markedly affected by buying and selling prices for cattle. Substituting current prices for the inputs on your farm will allow recalculation of the estimated returns.

Comments and Conclusions

1. Precipitation during the growing seasons involved in this experiment ranged from 13.2 cm to 44.7 cm (av. 22.9 cm). This resulted in a range in pasture dry matter production from 1766 to 5758 kg/ha (av. 4122 kg/ha). The highest precipitation and dry matter yield occurred during the final year of the project, indicating that production was influenced more by precipitation than by the age of the stand.

2. The "put and take" system is fine for assuring that the pasturage is utilized at the optimum stage of maturity but creates some animal management and economic problems. Excess cattle have to be purchased, increasing investment, buying and transportation costs per unit of pasture. Selling surplus cattle in early summer may not be advantageous (although in the calculation of returns we have assumed that they brought the same market value per kg as those cattle sold at the end of the grazing season). If surplus steers are removed to the feedlot over a period of time, extra labor and facility costs are involved and a ration must be used that will allow cattle to full feed without digestive disturbances unless sufficient numbers are removed at one time to warrant conventional (high grain) feeding practices.

3. The pasture & silage system allowed a reduced, but almost constant number of cattle to produce as much liveweight gain per unit of pasture as was produced under the "Put and Take" system, thus improving the efficiency of animal use.

4. Feeding oat soilage on pasture was also effective in maintaining higher and more constant stocking rates. The maintenance of a consistent supply and quality of oat soilage can be facilitated by seeding three or four areas at 2-3 week intervals beginning in late May. This practice necessitates daily harvesting, which can be a problem, particularly in wet weather. It might be more efficient to completely harvest one large oat field, ensile the material and feed it on pasture as required.

5. Under the pricing situation assumed, the feeding of barley to cattle on pasture would appear to have some advantages. Rate of gain was higher than for forage-fed cattle, which in addition to improving feed efficiency, would also hasten the finishing process compared to forage-fed cattle. The ability to reduce the variability in stocking rate is also of practical importance. This system would provide a useful outlet for low cost or difficult to market cereal grain.

6. One should exercise judgment when attempting to maintain cattle on pasture by supplemental feeding. If it becomes obvious that the pasture is being overgrazed or is suffering physical damage due to trampling, fouling, etc., then it is better to remove the cattle to a feedlot or perhaps to an annual (emergency) pasture. If the grazing pressure occurring during supplemental feeding is resulting in good utilization of the pasture without overgrazing, then the pasture may well benefit because of the additional

nutrients being deposited on it by the grazing cattle as a result of consuming off-pasture feed. In this project it is noted that the dry matter production of the pastures tended to be slightly higher where supplemental feeding was carried out.

7. Implanting steers with Synovex S (200 mg progesterone + 20 mg estradiol/hd) resulted in increasing liveweight gains by 0.25 kg per head per day, a significant factor in efficient pasture management. With the exception of heifers being raised for breeding stock, all steers and heifers being reared as market animals should receive the appropriate implant.

8. The average daily gains (kg) of the three breeds or breed crosses are summarized by pasture treatment in Table 18.

Table 18. Average daily gains of three "breeds" of steers on pasture (kg/hd/day) (average of six years)

Breed or Cross	Put & Take	Pasture & Silage	Pasture & Oat Soilage	Pasture & Barley
Herefords	1.05	1.03	1.00	1.20
Angus	0.93	0.91	0.89	1.07
Charolais-Angus	1.06	1.07	1.09	1.21

CRESTED WHEATGRASS VS RUSSIAN WILD RYE FOR PASTURE

Crested wheatgrass (Fairway, 30 cm rows) was compared to Russian wild rye (Commercial strain, 46 cm rows) as pasture for yearling steers over a five year period. "Put and Take Stocking" was practiced and pastures were fertilized with 90 kg N/ha.

Results are summarized in Table 19.

Table 19. A comparison of crested wheatgrass and Russian wild rye as pasture for yearling steers (5 year average)

	Crested wheatgrass (CWG)	Russian wild rye (RWR)
Area of pasture	7 ha	7 ha
Average initial weight (kg)	272.7	272.7
Grazing period (days)	94	99
Stocking rate (steers/ha)	3.3	3.7
Average daily gain (kg)	0.97	0.84
Gain per ha (kg)	288	299
Dry matter produced/ha (kg)	3149	3564
Dry matter consumed/ha (kg)	2616	3181
% utilization	83	89
Dry matter consumed/unit of gain	9.1	10.6

Average daily gain of steers grazing RVR was less than for steers grazing CWG. However CWG tended to become dormant in mid-summer and to lose nutritive value and palatability rapidly if it was allowed to head out. As a result gain per ha was greater for the RVR pastures. It is interesting to note that gains of CWG pastured steers were 17% more efficient than those of steers grazing RVR. The results of this test would indicate that for optimum pasture use, crested wheatgrass should be part of a multi species grazing system where its use could be confined to the early part of the grazing season or to other periods of rapid growth and that it should be grazed intensively enough to prevent heading.

Russian wild rye provides both early and late grazing but should be given a mid-season recovery period.

ANNUAL CROPS FOR PASTURE

While annual crops cannot replace perennial forages in many situations where land is prone to erosion or is difficult to cultivate, they do have a very important role to play in providing supplemental or emergency grazing when perennial pastures fail to meet the requirements of the grazing animal, particularly in late summer and fall. Because of their ease of establishment, annuals can also be used in cleaning up weed and brush-infested pasture land prior to it being sown to less competitive perennial crops, particularly on pastures that are amenable to cultivation.

Many grass species seeded to permanent pasture in Saskatchewan are early season producers. During the summer, grasses such as crested wheatgrass need a rest to recover vigor. Spring-seeded annuals can be used to provide

pasture during this period. Oats, wheat and barley can be used but the winter annuals have a distinct advantage when spring seeded. Without cold winter temperatures they do not undergo a vernalization process. Thus, rather than producing seed-bearing stems they will produce vegetative tillers with a low growing point. These plants are leafy, regrow rapidly, and are easy to graze thus providing additional good quality forage well into the late summer and early fall.

Yields of some of the crops evaluated as pasture are shown in Table 20.

Table 20. Yields of annual crops as pastures* in Black (Lacombe) and Gray-Wooded soils (Bluffton) in Alberta (five year average)**

Crop	Yield (kg DM/ha)	
	Black soil (pH 7)	Gray-Wooded soil (pH 6)
Foothill oat	3347	2106
Bonanza barley	2190	1365
Glenlea wheat	2011	1278
Norstar winter wheat	4502	1159
Kodiak winter wheat	4202	1334
Italian ryegrass	5014	1403

*Simulated, multiple cuts - cut to 5 cm when reaching 25-30 cm.
**Condensed from Annual Crops for Forages in the Alberta Parklands.

PRODUCTION PRACTICES

a) Seeding rates

40-80 kg/ha for oats, 70 kg/ha for winter wheat, 20 kg/ha for Italian ryegrass (IRG).

b) Seeding dates

Timing will depend on expected period of use. Depending on growing conditions, grazing can start 4-6 weeks after seeding. Regrowth can be grazed throughout the growing season. A four-field grazing system should allow for optimum utilization, seed fields at 10-14 day intervals.

c) Fertilizer use

Nitrogen (ammonium nitrate 34:0:0) 50 kg/ha on Black soils, 75 kg/ha on Gray-wooded soils.

Phosphorus, 25 kg P_2O_5 (11:55:0) on both soil types.

d) Underseeding

Oats, seeded in mid-May (40 kg/ha) for silage production can be underseeded to winter wheat or fall rye (70 kg/ha). After removal of the oats, the winter wheat or fall rye (given reasonable moisture) can provide grazing well into the fall.

e) Norstar winter wheat is very susceptible to rust disease. Use rust resistant varieties for spring seeding to avoid serious crop loss in late summer.

MANAGING ANNUAL PASTURES

- Seed into a firm seedbed at 25-50 kg/ha (1-2 bu/ac). A soil test should be taken or fertilize at the recommended rate for cereal production. Nitrogen, phosphorus and sulphur are important. Potassium may be deficient in the Carrot River area of northeast Saskatchevan.

- Summer annuals should be seeded in early May for summer pasture or late June for fall pasture. Winter annuals should be seeded in September for early spring pasture or early May for summer pasture which will carry through until freeze-up if sufficient soil moisture is present.

- Start grazing when oats are around 25 cm (10") tall, spring seeded winter wheat and fall rye can be grazed at 12-15 cm (5-6").

- Move to next field before oat height gets below 7-8 cm (3").

- Move as required to keep oats from maturing. If cattle can't keep up, remove mature stand as silage (for spring seeded winter wheat and fall rye, control grazing by adjusting stocking rate - not by mechanical harvesting).

- Use electric fencing to facilitate management of cattle.

- There is a possibility of nitrate poisoning following a sudden hot, dry spell or a killing frost, especially on well fertilized (N) fields. It is recommended that a representative sample from the most severely affected portions of the field be analysed for nitrate content. If over 1% nitrate, watch cattle closely for symptoms (labored breathing, exposed tissue, nose turning blue) and be prepared to pull cattle off pasture, dilute pasture with other feeds (hay, silage) and treat affected animals promptly - administer methylene blue (1% solution) intravenously (into the blood stream) to provide 2 mg of methylene blue per kilogram of body weight (1 mg/lb.).

EXAMPLE YIELDS/PRODUCTIVITY

1. Supplementary oat pastures at Melfort have yielded 3800 to 6000 kg/ha and carried from 100 to 150 steer days of grazing/ha. They have also

extended the productive season by as much as 40 days. Oat pastures grazed by lambs throughout the season have produced gains of over 560 kg/ha.

2. At Melfort an 18 ha pasture of winter wheat (following removal of an oat crop for silage) accommodated 38, 575 kg cows from August 5 to October 5 and supported a rate of gain of 0.5 kg/cow/day. In another year, both winter wheat and fall rye were seeded with oats (separate fields). The oats were removed as silage in June (4.0 to 3.4 tonnes/ha or the "rye" and "winter wheat" fields respectively). The underseeded annuals, plus oat regrowth, provided 112 cow days/ha of grazing and supported a gain of 1.07/kg/head/day. In another test, the underseeded annuals supported rates of gain from 1.3 to 1.5 kg/head/day.

3. At the Termeunde Research Station at Lanigan (light black, Oxbow sandy loam), winter wheat seeded alone on three, 12 ha paddocks (67 kg/ha) in early May and fertilized with 57 kg N/ha was grazed rotationally with a field of crested wheatgrass. The winter wheat was grazed starting in late June. Averaging two years, 90 cow-calf units were supported over a 113 day grazing season. Dry matter production was estimated at 6400 kg/ha. Gain of cows and calves averaged 330 kg/ha with calves averaging 1.30 kg gain/head daily.

ADVANTAGES OF ANNUAL PASTURES

- Easy to establish (on summerfallow).

- Can be timed/managed to provide pasture when required and particularly during the late summer to freeze-up, when perennial pastures are usually in decline or unproductive.

- Provides good protection of soils from erosion compared to summerfalloving.

- If not required for grazing, can be harvested for silage, hay or grain.

- Can be alternated with perennial pastures without adversely affecting animal performance provided that the stage of maturity is similar on both pastures.

DISADVANTAGES OF ANNUAL PASTURES

- Impractical and inadvisable to grow on soils that are difficult to cultivate or prone to erosion.

- Cost per unit of feed is normally greater than for perennial grass-legume mixtures over the long run. Especially uneconomical on poorer soils because of high inputs and low returns.

- Must be seeded each year, thus higher seeding costs than for perennial forages.

- Spring-seeded winter wheat is very are susceptible to rust unless resistant varieties are grown.

- If not well managed, wastage from trampling and fouling can be high (20-60%) depending on the density and height of the stand.

- Scours can occur if pastures are grazed at an immature stage.

- Nitrate poisoning may be a problem if the growth of the crop is suddenly arrested due to drought or frost. Normally a nitrate level of 1% of dry matter is considered potentially hazardous, however cattle grazing oat pasture with 2% nitrate showed no adverse effects, perhaps because they were consuming the forage at a rate at which the nitrate could be metabolized before reaching toxic blood levels.

MECHANICAL (ZERO) GRAZING OF ANNUAL PASTURES

When oat stands are heavy (or are on unfenced fields), it may be preferable to harvest the crop with a forage harvester and feed the green chop to cattle in drylot (or on perennial pasture to supplement a declining pasture supply). When green chop (soilage) was fed once daily to steers in drylot at Melfort, liveweight gain was increased from 145 to 350 kg/ha harvested (a 2.4 fold increase). Average daily gains were reduced slightly, because of the elimination of selective grazing. It was also noted that cattle preferred chopped over shredded material, perhaps because of the more uniform, "smaller particle" feed.

Mechanically harvesting cereal (or any other) pastures, while increasing the efficiency of pasture utilization, involves higher labor and equipment costs and can be a problem in wet weather. Perhaps some other system (silage, haylage) would be preferable, in that it would allow removal of the crop in one operation and at a more consistent nutritive value.

Feeding mechanically grazed material in drylot, vs grazing in place, does create a manure handling operation if plant residues are to be returned to the soil. If fed on pastures, however, the added nutrients and fibre from off pasture fields will benefit the pastures.

GRAZING TRIALS WITH CATTLE AND SHEEP ON ANNUAL PASTURES

SPRING SEEDED ANNUALS AS PASTURES FOR HEIFERS

At the Termuende Research Station, Lanigan, Saskatchevan, heifers grazed spring seeded fall rye and winter wheat from July through September 1987.

The annuals were seeded the first week of May at 67 kg/ha at a depth of 5 cm into two 8 ha (20 ac.) paddocks and fertilized with 168 kg/ha of 34-0-0. The good quality of the annuals and performance of the pastures can be noted in Table 21.

Table 21. Nutrient content and productivity of fall rye and winter wheat pastures

	Fall Rye		Winter Wheat	
Date sampled:	July 9	Sept. 14	July 9	Sept. 14
Constituent*				
Protein (%)	28.5	11.8	26.6	11.7
TDN (%)	68.8	58.8	65.6	56.6
Calcium (%)	0.75	0.55	0.55	0.44
Phosphorus (%)	0.36	0.24	0.36	0.21
Nitrate (%)	0.88	trace	0.40	nil
ADF (%)	24.6	35.0	27.6	38.1
Production Criteria (67 days)				
No. of head/8 ha	36		36	
Dry matter produced/ha (kg)	4338		3608	
Average daily gain (kg)	0.82		0.85	
Liveweight gain (kg/ha)	244		252	

*Values presented on a dry matter basis, analysed at the Feed Testing Laboratory, University of Saskatchevan, Saskatoon.

A COMPARISON OF ANNUAL VS PERENNIAL FORAGE CROPS AS PASTURE FOR SHEEP

Over a four to six year period, perennial grass-legume pastures were compared to cereal pastures grazed by ewes and lambs. Three 0.32 ha paddocks were assigned to each of four treatments. Ewes were removed when the lambs reached 25 kg in weight. The four original treatments were:

1. Rambler alfalfa & Magna bromegrass (2.24 and 9 kg/ha, respectively).

2. Melrose-sainfoin & Magna bromegrass (22.4 and 9 kg/ha, respectively).

3. Random oats (80 kg/ha).

4. Melrose sainfoin (44.8 kg/ha) for 2 years then replaced with Bonanza barley (sainfoin could not compete with weeds).

Annuals were seeded on May 2, May 27 and June 11. All paddocks were fertilized with 90 kg N and 45 kg P_2O_5 at the end of April.

The results are summarized in Table 22.

Table 22. Comparison of perennial grass-legume mixtures with annual cereals as pasture for ewes and lambs

	Brome-alfalfa (6 yr. av.)	Brome-sainfoin (6 yr. av.)	Oats (7 yr. av.)	Barley (4 yr. av.)
Length of grazing season	114	114	88	82
Stocking rate (head/ha)	20.3	19.0	20.0	19.5
Gain/ha (kg)	330	282	328	305
Av. daily gain of lambs (g)	186	169	191	196
Dry matter production (kg/ha)	5385	5156	5887	5883
Dry matter consumed/unit gain	11.9	13.2	15.4	15.5
Dry matter harvested as hay (kg/ha)	646	645	—	--

Comments (Table 22)

1. Perennials were utilized more efficiently for meat production than were annuals, probably due to the greater wastage on annual pastures because of trampling.

2. While oats will provide pasture during the year in which the perennial pasture is being established, input costs (seed, cultivation, seeding, weed control) are higher for annuals and their potential is probably greatest when utilized to overcome shortages of perennial pasture in years of below average precipitation.

A COMPARISON OF OAT VARIETIES FOR LAMB PRODUCTION

Because of interest in annual pastures, particularly to provide supplementary grazing for livestock on perennial pastures, it was felt advisable to evaluate several different oat varieties. Seeding rate was 79 kg/ha and fertilizer was applied at the rate of 37 kg N and 27 kg P_2O_5 per ha. The experiment ran for three years and involved two replicates of four 0.09 ha plots with sheep as the grazing animal. In one year lambs were used, in another ewes and lambs, and in the third year, ewes were removed about 3 weeks after the start of the test.

Results are presented in Table 23 and are confined to dry matter yields and lamb performance.

Table 23. A comparison of oat varieties for lamb pasture

Variety/selection	Fraser	Harmon	Kelsey	OA 123-1
Av. daily gain (kg)	0.24	0.22	0.21	0.21
Lamb days/ha	2559	2510	2376	2386
Dry matter produced (kg/ha)	5454	5329	5604	5144
Dry matter consumed (kg/ha)	3936	3810	4078	3593
Creep feed eaten (kg/ha)	1077	1046	1135	1112
Lamb gain (kg/ha)	595	555	502	496

Comments (Table 23)

1. Over the three years, Fraser and Harmon were superior to Kelsey and OA 123-1.

2. During the two years when creep feeding was employed, average daily gains across all varieties were considerably higher (0.28 & 0.22 vs 0.16 kg per head per day).

3. Liveweight gain of lambs per unit of land compared favorably with that of steers receiving barley on brome-alfalfa pastures over the period 1970 to 1972 (537 kg/ha for lambs vs 418 kg/ha for the steers). If average dressing percentages (48 and 56%) are applied the difference becomes somewhat less (258 vs 234).

COW-CALF PRODUCTION ON GRAY-WOODED SOIL PASTURES (PATHLOW PROJECT)

The Melfort Research Station initiated a large-scale beef cow-calf and pasture management study in 1974. The project, in cooperation with the Saskatchevan Horned Cattle Trust Fund and the Lands and Livestock Branches of Saskatchevan Agriculture, was designed to evaluate time of calving (early and late), winter rations, cow size (Angus x Hereford vs Simmental x Hereford) and different methods of renovating depleted bushland pastures in the Aspen Parkbelt.

A 513 ha (section and a half) area of marginal gray-wooded soil was selected at the Pathlow Community Pasture, 40 km southwest of Melfort. Most of the land had been cleared, broken and reseeded to bromegrass, alfalfa, creeping red fescue, and alsike clover in the mid 1960's. No fertilizer had been applied. By 1974, the carrying capacity and soil fertility were very low.

The primary objective of this project was to evaluate two methods of

rejuvenating the existing pasture and to compare these to a continuously grazed, unfertilized control (original stand) pasture. The two methods were:

1. Using fertilizer and rotational grazing (4 sets of 4, 8 ha paddocks).

2. Stepvise rebreaking and reseeding, plus application of fertilizer and rotational grazing (4 sets of 4, 8 ha paddocks).

These two methods and the control were assessed in terms of dry matter (DM) yields of pasture and liveweight gains of cov-calf units.

Within the six-field system, two paddocks were broken in 1975 and reseeded to Russian vild rye (Savki) (6 kg RVR + 19 kg oats/ha) in the spring of 1976, with the goal of extending the grazing season. In each of 1979 and 1981, an additional paddock, broken the previous year, vas reseeded to smooth bromegrass (Carlton) and alfalfa (Rambler) at 9 kg and 2 kg, respectively, along with 19 kg of oats per ha. During the summer of 1983, another paddock vas vorked down, fertilized and reseeded to crested vheatgrass (Parkvay) at 9 kg/ha. In 1985, the remaining paddock in the six-field system vas sprayed with herbicide (Roundup) and seeded vithout cultivation to meadov bromegrass (Regar) and alfalfa (Rambler) at the rate of 9 and 2 1/4 kg/ha.

Half of the paddocks in each of the two systems were fertilized in alternate years with 90 kg N, 45 kg P_2O_5 and 9 kg S/ha. This was done to stimulate early production in part of the system to provide an improved seasonal production pattern. It was found that the fertilized fields were grazed twice during the season while unfertilized paddocks produced little regrovth following the first graze.

Angus x Hereford and Simmental x Hereford cows (about 150 of each cross) and their Charolais-sired calves were used on the project. Some were placed on either Russian vild rye or crested vheatgrass paddocks in late May (av. May 25) or vhen the grass was 13-15 cm high. On the fertilized 4-field system, grazing started a veek later (av. June 3) vhile the control pasture vas grazed starting about the end of the first veek in June (av. June 7).

Herbage yields were determined by using cages to protect small representative areas within each paddock, from grazing cattle. Cattle were veighed vhen they moved from one paddock to the next within each system (1 1/2 - 2 rotations/season).

Calves were castrated in early September and vere veaned and removed from pasture in late September or early October at vhich time they were trucked to the Melfort Station and placed on pasture prior to going onto feeding experiments. Cows usually remained on grass until late October vhen the forage vas depleted or vhen early snowstorms terminated grazing.

Since 1974, non-fertilized control fields have produced, on average, 1135 kg DM/ha. Since 1978, pastures fertilized in the fall or spring just

prior to the grazing season produced 2906 kg DM while fields fertilized the previous year produced 1588 kg/ha (Table 24). The use of fertilizer in the fall resulted in a 2.7 fold increase in pasture DM yield compared to unfertilized control pastures. In the second season following fertilizer application (carryover effect) there was a 1.5 fold increase in production. A residual fertility/management effect has been observed when comparing fertilizer response in 1976 with that in 1985. In 1976, fields fertilized the previous fall had nearly twice the response to fertilizer, compared to the non-fertilized stands, while in 1985, there was a three-fold increase in DM production due to fertilizer. Soil tests have shown only slight increases in soil fertility over the ten years, perhaps indicating that fertilizer is being utilized largely in the year of application and that there might be some justification for evaluating higher rates of application.

The use of fertilizer, on original stands, has increased gains and grazing days per hectare. From 1977-1985, the fertilized and rotationally grazed treatment produced 45 kg of cow gain and 89 kg of calf gain per ha, while the continuously grazed control fields produced 24 kg of cow gain and 58 kg of calf gain/ha (Tables 25 and 26). The fertilizer has produced an additional 21 and 31 kg of cow and calf gain, respectively, per ha. Ignoring the cow gain, and assuming a market value of $2.30/kg for calves, the extra gain would be worth $72 per ha. Valuing the fertilizer at 53¢, 60¢ and 40¢/kg for the N, P_2O_5 and S, respectively, the cost of fertilizer would be $39 annually, obviously considerably less than the value of the calf gains. In retrospect and considering the fertilizer trials reported elsewhere in this publication, it is unfortunate that only half of the most economical fertilizer treatment (90 kg N, 45 kg P_2O_5 and 22 kg S/ha/year) was used on the pasture study. Barring a shortage of moisture, it would appear that rates higher than those used could have been justified.

The use of fertilizer had other benefits of economic significance. Length of grazing season from 1975 to 1985 increased from an average of 117 days on the non-fertilized control paddocks to 129 days, on average, for the rotationally grazed, fertilized pastures. Control pastures averaged 1.8 ha/cow per season compared to 1.14 ha/cow for the fertilized rotationally grazed treatments. Thus, land and facility costs per animal unit were reduced as a result of increasing pasture productivity.

Reseeding and fertilizing, plus rotational grazing, also increased forage dry matter production (Table 27) and lengthened the grazing season, in spite of the failure to establish good stands of Russian wild rye.

Excellent stands of bromegrass-alfalfa were established following breaking and reseeding. Those stands that were reseeded and fertilized in 1979 and fertilized in late fall or early spring of 1981, 1983 and 1985, produced 4024 kg DM/ha in 1985; those fertilized and reseeded in 1981 and fertilized in late fall or early spring of 1983 and 1985 produced 3567 kg/ha. Crested wheatgrass seeded in 1983 and fertilized in 1984 averaged 3912 kg DM/ha in 1985. In comparison, the original swards (4-field system) that were fertilized in the spring of 1985 averaged 3492 kg/ha in 1985, while the

non-fertilized, non-reseeded control pasture produced 1121 kg/ha in the 1985 growing season.

The Russian wild rye pastures were not successfully established. A cover crop of oats was seeded with the RWR to protect the soil from erosion and to trap snow during the winter. The use of this companion crop and the heavy late-season grazing to remove it, undoubtedly affected the ability of the RWR to become properly established. In the initial years of grazing, RWR made up 82% of the DM produced, with bromegrass, quackgrass, and weeds accounting for 18%. By 1984, bluegrass and quackgrass have virtually replaced the RWR except on some of the drier knolls. A Russian wildrye pasture established on a productive silty-clay loam at Melfort in 1959 is still producing 31 years later, and providing excellent early and late grazing, a characteristic of considerable importance to the cow-calf producer.

The sod-seeding of meadow bromegrass and alfalfa using Roundup to kill existing vegetation did not produce satisfactory results under the conditions experienced. Further work should be done to develop this technique as it would be advantageous on stony land and reduce susceptibility to soil erosion.

The six-field system produced 43.3 and 95.6 kg of cow and calf gain/ha, respectively; the four-field 44.6 and 88.8 kg/ha, while the control pastures produced 23.5 kg of cow gain and 57.5 kg of calf gain/ha. It must be emphasized that during this period some of the fields were reseeded and thus unavailable for grazing. Thus, the relative performance of this system should improve with time, provided that species or mixtures of species selected have long, productive life spans over which to spread the cost of reseeding operations.

Grazing seasons averaged 143 days on the six-field system, 129 days for the four-field system and 117 days on the control pastures. The earlier spring grazing on the six-field system was due to the crested wheatgrass and Russian wild rye pastures.

The cost of rebreaking and reseeding in northeastern Saskatchewan in 1986 was around $132/ha ($45 for breaking, $48 for working and $39 for seed). It is thus important that this be spread over as many years as possible to justify the cost.

Extending the grazing season is particularly important in cow-calf operations. Each additional day on pasture eliminates the cost of feeding a cow-calf unit in drylot and could mean one less day exposed to diseases in a muddy feedlot. At current feed and yardage prices, it costs about 75¢ per day to keep a 550 kg lactating cow in drylot. If this cost can be avoided, the saving could help to cover pasture reseeding costs.

At this stage it is concluded that under the conditions experienced in this project, the cost of fertilizer can be more than covered by the

increased value of the calf gains alone. Depleted stands can be markedly improved by the application of fertilizer every other year (and likely further improved by the use of higher levels of fertilizer). The economics of reseeding bushland pastures to more productive species will depend on the success with which potentially productive, long-lived species can be established. The high cost of breaking and reseeding indicates the importance of careful grazing management to maintain desirable species and prevent brush regrowth.

Table 24. Effect of fertilizer on average forage production on original stand (kg DM/ha) - Pathlov, Saskatchewan

Year	No Fertilizer Control	Fertilized 90 kg N, 45 kg P205, 10 kg S/ha	
		Previous Fall* before grazing	Year earlier 2nd grazing season*
1976	1731	3175	--
1977	1490	--	1753
1978	1145	2862	1341
1979	1118	2315	1626
1980	517	1826	1020
1981	649	1936	965
1982	923	3160	1627
1983	1201	3963	1912
1984	1410	3732	2383
1985	1121	3196	1928
1986	630	2893	1322
Average	1085 kg/ha	2906 kg/ha 2.68 x increase	1588 kg/ha 1.46 x increase

*Paddocks fertilized on alternate years.

Table 25. Cow performance on pasture (av. 1977-1985)

	Length of grazing season (days)	Ha/cow	Grazing days/ha	Gain/ha (kg)	ADG (kg)	Initial weight (kg)	Final weight (kg)	Total weight gain/hd (kg)
Control	111.8	1.84	66.1	23.5	0.34	465.1	503.5	39.0
4 Paddock								
Early	119.5	1.19	102.9	45.5	0.46	472.9	526.4	54.1
Late	123.1	1.09	114.7	43.7	0.39	463.8	510.7	47.5
6 Paddock								
Early	136.9	1.21	115.1	41.8	0.36	474.9	524.2	50.7
Late	135.1	1.12	123.4	44.8	0.38	460.8	510.4	50.8

Table 26. Calf performance on pasture (av. 1977-1985)

	Length of grazing season (days)	Ha/ calf	Grazing days/ha	Gain/ha (kg)	ADG (kg)	Initial weight (kg)	Final weight (kg)	Total weight gain/hd (kg)
Control	102.9	1.98	54.0	57.5	1.10	117.2	229.3	112.1
4 Paddock								
Early	100.4	1.31	78.6	86.6	1.11	122.8	233.6	110.8
Late	106.1	1.22	88.4	91.1	1.04	78.5	187.9	109.2
6 Paddock								
Early	119.6	1.33	92.3	95.0	1.04	119.6	242.3	122.3
Late	117.4	1.24	97.2	96.3	1.01	77.4	194.6	116.9

Table 27. Pasture dry matter production by systems (Pathlov 1983-86 (kg/ha)

	1986	1985	1984	1983
Control pastures	669	1121	1355	1202
4-Field				
Fertilized paddocks	2690	3492	3732	3963
Non-fertilized paddocks	1535	1928	2383	1912
6-Field				
Crested wheatgrass	3777 (fert)	3912	6872 (fert)	--
1979 Brome-alfalfa	2247	4023 (fert)	3043	5490
1981 Brome-alfalfa	1817	3567 (fert)	4230	5323
Reseeded, brome-alfalfa - 1979, 1981	2032	3795 (fert)	3637	5407 (fert)
1976 Russian wild rye				
- fertilized	2535	3427	3558	3668
- non-fertilized	1365	1702	2091	1824

EFFECT OF PASTURE MANAGEMENT ON THE DISTRIBUTION OF FORAGE SPECIES ON THE PATHLOV PROJECT DURING A FIFTEEN YEAR PERIOD (1975-1989)

In 1975, 1976, 1978, 1980, 1982, 1984, 1988 and 1989 detailed plant surveys were undertaken each spring to determine the change in the proportion of various plant species in areas that had been reseeded and fertilized compared to areas that had been fertilized only.

The results of this study are summarized in Tables 28, 29, 30 and 31.

COMMENTS

1. A study of Tables 28 to 31 indicates that for all reseeded forage species, less than acceptable success was achieved in eliminating other species that were present prior to reseeding. Inability to control existing weeds and other forages during the short period from breaking to reseeding is undoubtedly the cause.

2. In this project the Russian wild rye suffered from the effects of a very vigorous stand of oats (used as a companion crop to reduce the possibility of erosion) and the grazing of oats late in the season. This undoubtedly affected the ability of this crop to compete with weeds and other less desirable forage species.

3. In view of the potential of the cultivated forage species used in this project, to provide good yields of high quality pasture over a number of years, it is imperative that research be conducted to determine whether the species are well adapted to the gray wooded soils at the Pathlov site and if so, what pasture establishment practices are required to ensure the elimination of highly competitive, low producing forage species. Will the cost of such practices be justified by the increased productivity over the lifetime of the stand? We don't tolerate weeds in cereal and oilseed crops simply because they may take over. We should be just as concerned about controlling undesirable species in pasture stands.

4. Where time and cost preclude thorough elimination of existing species prior to seeding, it may be preferable to fertilize the existing stand.

Table 28. Forages as percent of total ground cover; Pathlov pasture, 4-field rotation, original stand, fertilized every second year

Year	Legumes (Alfalfa + alsike clover)	Smooth brome-grass	Creeping red fescue	Kentucky bluegrass	Dandelion	Misc. other species
1975	2.7	17.2	52.9	1.2	21.5	4.5
1976	1.3	16.0	57.2	2.9	16.1	6.5
1978	6.3	15.7	55.5	4.9	11.0	6.6
1980	10.6	19.7	46.1	6.8	9.7	7.1
1982	4.3	26.0	31.7	15.1	13.6	9.3
1984	3.8	22.6	29.3	17.3	16.6	10.4
1988	3.4	29.2	6.8	36.3	9.1	15.0
1989	0.9	28.1	9.8	42.4	7.3	10.2

Source: J. Waddington

Table 29. Forages as percent of total ground cover Pathlov - pastures reseeded in 1981 or 1979 with a bromegrass-alfalfa mixture

Year	Legumes (Alfalfa + alsike clover)	Smooth brome-grass	Creeping red fescue	Kentucky bluegrass	Dandelion	Misc. other species
1975	2.7	13.1	56.2	1.2	21.0	5.8
1976	1.4	16.9	50.6	6.4	18.8	5.9
1978	9.0	13.3	47.5	6.5	11.5	12.2
1980	16.8	21.7	23.7	8.2	11.2	18.4
1982	10.4	41.3	2.4	6.1	14.0	25.8
1984	11.3	38.8	7.1	10.4	20.9	11.5
1988	7.2	33.2	2.7	32.2	6.9	18.0
1989	2.8	33.0	5.2	37.1	6.3	15.6

Source: J. Waddington

Table 30. Forages as percent of total ground cover Pathlow pasture. Fields seeded to Russian wild rye in 1977

Year	Legumes (Alfalfa + alsike clover)	Smooth brome-grass	Creeping red fescue	Kentucky bluegrass	Russian wild rye	Dandelion	Misc. other species
1978	2.8	10.2	14.7	19.0	24.0	3.1	26.2
1980	4.6	12.8	15.7	28.2	20.3	3.3	15.1
1982	6.0	15.6	7.9	32.5	16.1	3.4	18.5
1984	5.2	14.9	9.5	39.3	5.3	5.5	20.3
1988	2.3	19.3	2.9	50.7	4.1	4.1	16.7
1989	0.8	17.8	3.1	52.4	3.6	8.3	14.0

Source: J. Waddington

Table 31. Forages as percent of total ground cover crested wheatgrass seeded in 1983 and meadow bromegrass seeded in 1985

Year	Legumes (Alfalfa + alsike clover)	Smooth brome-grass	Kentucky bluegrass	Crested wheat grass	Dandelion	Misc. other species
1984	0.1	4.0	12.4	63.5	6.4	13.6
1988	1.3	14.2	24.2	41.4	8.1	10.8
1989	0.2	12.0	34.3	41.2	5.9	6.4

	Legumes (Alfalfa + alsike clover)	Smooth brome-grass	Kentucky bluegrass	Meadow brome grass	Dandelion	Misc. other species
1984	3.1	33.7	14.7	--	17.6	29.7
1988	3.1	27.2	18.8	21.1	6.5	23.3
1989	1.2	22.2	25.8	27.0	5.0	18.8

Source: J. Waddington

PASTURE AND RANGE RENOVATION

Reseeding land which is presently in rough pasture or rangeland can be difficult, expensive, and risky. Tree and brush removal is expensive. Stones may break machinery. Existing vegetation may be difficult to kill, and will re-establish from the seed stored in the soil. Cultivation may bring shallow salt deposits to the surface, and can leave soils prone to wind and water erosion.

A number of factors will influence the success and economics renovating pastures. These include, topography, soil type, productive potential of the soil, availability and quality of the water supply and the type and density of trees, shrubs and poisonous or unpalatable plants.

A large proportion of Saskatchewan's grazing lands can be found in the Aspen Parkland region of the province. The majority of the land, especially the crown-owned community pastures is seeded to tame pastures. Many of these pastures were developed in the early to mid 1960's from abandoned submarginal farm sites on stony, Gray-wooded soils.

LAND CLEARING

Traditionally, land has been cleared using a bulldozer of 100 horsepower or greater. The blade is slightly raised and angled and the trees are pushed out of the ground. Alternately, a V-shaped cutter mounted on the front of large (135 HP or greater) bulldozer is used to shear off the trees at ground level. The operation is carried out in early winter after the ground is frozen. In both cases the trees are piled in windrows about 200 feet apart and burned. In too many cases land was cleared indiscriminately, leaving little or no tree cover over large areas, depriving cattle of shade and fly protection, exposing the land to wind and reducing snow cover.

BREAKING OR REBREAKING

Old depleted or newly cleared land is broken using a heavy duty 28 inch or greater serrated tandem disk plow. This is usually pulled with a bulldozer or large 4-wheel drive tractor. A tandem offset disk plow will eliminate the twice over operation required with the single disk plow.

WORK DOWN

Following breaking of the old pasture stand or new land, additional tillage is carried out using a heavy tandem serrated farm disk. A heavy log or steel rail is pulled behind the tandem disk to help break up the sod clumps and level the land. The more tillage the better, as a well worked and firm seedbed is necessary for a good seed establishment. However, overpulverization of the soil can leave it very susceptible to erosion and

crusting before the pasture is well established.

SEED DRILLS

There are very few seed drills designed especially for seeding in roughland and stony pastures. The ideal drill must be heavy duty, and have independently suspended seeding disks with depth control devices to limit seeding depth to about 1.3 cm. Spacings of about 30 cm (12 inches) will provide adequate pasture stands in the north. These spacings also allow small rocks to pass between the seeding disks. Separate seed boxes for grass seed and legumes are required. Grass seed boxes must have agitators for the grass seeds and smooth flowing, accurate seed metering systems. The heavy duty no-till seed drill currently available at major Canadian farm implement dealers can be successfully used, or specially designed roughland seed drills can be imported from the mid western United States, Europe and Australia. The Prairie Agricultural Machinery Institute in Portage la Prairie, Manitoba. and Humboldt, Saskatchewan, have evaluated several seed drills and reports are available. The Agriculture Canada Research Stations at Melfort and Swift Current have also evaluated seed drills.

TIME OF SEEDING

Reseeding old depleted pastures should be done after the fields have been well worked and the old sod clumps are dead. If the area is reseeded too soon after breaking, the new stand will revert to the original plant species within a few years. Even if the sod clumps are dead, the ground contains viable seeds from the previous grass stands. These seeds will germinate and compete with the new introduced species. One way to reduce this problem is to seed spring or winter annuals such as oats, rye or wheat for one to three years. This will aid in clearing the seedbed of the previous forage stand. Another method is to spring seed fall rye and sweetclover. The stand can be rotationally grazed during the summer and early fall. The area should be worked down with heavy duty work down disks in the fall prior to freeze up. Moisture conditions are critical for deep tillage penetration. Seed as early as possible the following spring to take advantage of available moisture.

DIRECT SEEDING (SOD-SEEDING)

Seeding forages without cultivation has been researched in the gray-wooded soil zone over several years. The existing vegetation can be killed with an application of Roundup, but the seeds in the soil are not affected and re-establish along with the seeded forages. Alfalfa ca.. be established, or its presence increased, in pastures in the gray-wooded soil zone, sometimes by seeding directly into the existing sod, but more reliably by seeding into a previously-killed strip about a foot wide.

DEPTH OF SEEDING

Forage seeds will not establish if seeded too deep. Seeding depth should be no deeper than 1.5 cm in a well-packed seedbed (2.5 cm if seedbed is loose). It is essential that depth control devices and packing wheels or dragging cover chains be used. Broadcasting is usually not recommended because of uneven seed placement and improper seed cover.

COMPANION CROPS

A companion crop provides grazing, hay, or grain in the year of forage establishment, protects the land against wind and water erosion to some extent, and offers some protection to the forage seedling against extreme weather. Annual cereal stubble will also have the added benefit of trapping snow. On the other hand, companion crops compete with the forage seedlings for water, light, and nutrients, and make weed control more difficult because suitable herbicides might not be available that can be used on both companion crop and forage. As well, the yield of forage will be less the year following a companion crop, and this yield loss may continue for several years if establishment conditions were poor. Seeding rate can be adjusted according to the purpose of the cereal companion crop. If it is intended for protection from the elements, a very light seeding rate of a few kilograms per hectare is satisfactory. If a silage or grain crop is desired, half the normal seeding rate is recommended. Judicious grazing of companion crops will not damage the underseeded forage provided the soil is not so wet that the surface will be damaged by the cattles' hooves. A short, intensive graze is preferable to a long grazing period. The companion crop should not be grazed to such a degree that the forage seedlings are eaten off. (For more information on companion crops, see the bulletin, "Forage Crop Production in the Aspen Parklands of Western Canada".)

ECONOMICS

All alternatives must be considered before rebreaking existing pastures. Under long term grazing experiments at the Pathlov Research Site, it was questionable whether the cost of breaking and reseeding could be justified if fertilizer is already being used. However, if brush regrowth is the major reason for rebreaking then the costs might be justified. The cost of reseeding can also be warranted if crested wheatgrass or meadow bromegrass are being added to the rotational grazing plan for early spring grazing. Over time, recently reseeded pastures will revert back to the original species composition. If the pasture in question already contains adequate grass cover and some legumes are present the use of rotational grazing with extended rest periods will bring the forage stand back to adequate production. The use of fertilizer will also enhance this process. The terrain, amount of stones and current custom rebreaking costs will be the deciding factor for any type of roughland pasture renovation.

REJUVENATING LONG-TERM CRESTED WHEATGRASS PASTURES AT THE TERMUENDE RESEARCH STATION

As perennial grass stands age they decline in productivity. Breaking and reseeding is expensive, so, producers often look for alternatives. A combination of land and grazing management practices can help improve pasture and animal production.

Perennial pastures will respond to sod breaking and fertilization. Usin spikes or shovels at an 8-15 cm (3-6 inch) depth will encourage more vigorous growth. The application of nitrogen as either urea or ammonium nitrate will further enhance growth.

At the Termuende Research Station, three different management systems have been used on rejuvenated 40 year-old crested wheatgrass (CWG) stands.

CONTINUOUS

The continuous grazing system was on an 85 ha (210 ac.) CWG pasture which was seeded in 1940. In 1983, it was spiked with 15 cm (6 in.) shovels. Each April it is fertilized with 225 kg/ha (200 lb/ac) of 34-0-0. In 1987, the pasture was grazed by 119 cow/calf pairs from May 14 to Sept. 13, a total of 113 days. Stocking rate and animal average daily gain are shown in Table 32.

ROTATIONAL

The rotational grazing system is on 56 ha (140 ac.) of CWG seeded in 1936. In 1983, it was spiked with 15 cm (6 in.) shovels. Each April it is fertilized with 225 kg/ha (200 lb/ac) of 34-0-0. It has been fenced into 7 paddocks, each 8 ha (20 ac.) in size. In 1987, grazing began May 14 and ended Sept. 13. Eighty-five cows with calves grazed for 113 days.

The stocking rate for the rotation was 1.5 animal units/ha (AU/ha) and for the continuous, 1.4 AU/ac. This is equivalent to 170 Animal Grazing Days (AGD/ha) on the rotation and 158 AGD/ha on the continuous.

In addition to the improvement in stocking rate under the rotation, an improvement in animal production was also noted. The cows gained 0.18 and 0.15 kg/d on the rotation and continuous systems, respectively. The gain per day for calves increased from 0.9 kg/d on the continuous system to 1.25 kg/d on the rotation.

The rotation through the paddocks is flexible and is dependent upon the weather and the stage of plant growth. Early in the season when the pasture is in a rapid stage of growth, the stay in any one paddock averages 4 days. As the season progresses and plant growth slows, a stay in a paddock can be 7 days. This is adjusted according to moisture in any season.

COMPLEMENTARY

Nineteen hectares (47 ac.) of rejuvenated crested wheatgrass pasture was used with an area of 36 ha seeded in spring to winter wheat at 25 kg/ha (1 bu/ac) and Norgold sweetclover at 7 kg/ha. The area was cross-fenced into three fields of 11 ha each and fertilized with either anhydrous ammonia or 16-20-0-0 at 80 kg N/ha or no fertilizer applied.

The rotation began on May 15 and 70 cow/calf pairs on the crested wheatgrass pasture. On June 25 the herd began the rotation through the three winter wheat/sweetclover pastures. At all times they had access to the perennial grass as this area held the only water supply. The herd spent approximately 10 days in each paddock and were rotated through the paddocks three times before the grazing season ended on September 11. Animal production data are shown in Table 32.

Fertilizer applications increased forage dry matter yield of the winter wheat/sweetclover. These areas yielded a total of 6445 and 6373 kg DM/ha for the 16-20-0-0 and anhydrous ammonia treatments, respectively, and 5265 kg DM/ha for the unfertilized area. The application of the fertilizer increased the total dry matter yield by approximately 1140 kg DM/ha, an increase of 17.8%.

Table 32. Stocking rate and average daily gain (kg/ha) for cows and calves on different grazing systems

Grazing system	Stocking rate (cows & calves/ac)	ADG (kg/ha)	
		Cows	Calves
Complementary	1.55	0.11	1.35
Rotation	1.50	0.18	1.25
Continuous	1.41	0.14	0.9

BRUSH CONTROL WITH WIPER-APPLICATORS

When there is a clear difference in height between taller woody plants and/or weeds and shorter desirable plants as is usually the situation in pastures containing woody shrub and tree species, it should be possible to wipe sufficient herbicide on the brush or trees to kill them without affecting the desirable pasture plants. The advantages of a wiper-applicator are several. Herbicide is applied only to the target plants, which allows the use of a non-selective chemical or use of a more expensive chemical. There is no wastage of herbicide on non-target plants, so less will be needed, and there will be less or no effect on the surrounding environment.

Two designs of wiper-applicators, the wick applicator and the roller applicator have been tried for brush control in pastures, with mixed results. Of the two, the roller applicator has been the most effective in studies at the Pathlow pasture project. This consists of a cylinder 30 cm in diameter with nylon carpet glued to its exterior. The cylinder is rotated by a hydraulic motor. The cylinder is mounted on a frame attached to the three-point hitch of a tractor. The roller is set at a suitable height, the carpet saturated with herbicide and driven through the brush. The rotation of the cylinder wipes herbicide onto the brush. More herbicide is applied, either automatically, or by the operator when needed. Concentration of 0.5, 1.5, and 4.5% have been used, both of Roundup and of a 4:1 mixture of 2,4-D (Amine 500) and Tordon 22K. Overall, a 1.5% solution was the most dilute that still gave fairly consistent brush control. Typical results are shown in Table 33.

Table 33. Control of brush using herbicides applied with a carpet-covered roller. (%)

Species	2,4-D: Picloram			Roundup		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
Aspen Poplar	50	75	90	40	75	90
Balsam Poplar	40	70	90	40	70	90
Willow	40	80	100	50	75	90
Western Snowberry	40	50	60	40	75	90
Rose	0	20	70	0	20	40

Source: J. Waddington

SUMMARY POINTS ON MANAGING AN EXISTING PASTURE FOR OPTIMUM PRODUCTION

1) If purchasing feeder cattle, select growthy individuals carrying a minimum of fleshing consistent with good health.

2) If wintering your own feeders for use on pasture the following summer, aim for a rate of gain between 0.3 and 0.6 kg/head daily. Gains on pasture are inversely related to rate of gain the previous winter. In the Aspen Parkland wintering periods are normally around 250 days, thus feeding for lower (less economical) gains during the winter may not be compensated for by faster gains during the shorter grazing period.

3) Use growth stimulating implants, except for breeding herd replacements. On productive pastures this practice can increase daily rate of gain by 0.1 to 0.3 kg/head.

4) Don't place cattle on pasture before the pasture has obtained

reasonable growth (preferably at least 15 cm on continuously grazed pasture). At Brandon, grazing before May 20 reduced pasture yield by 1100 kg/ha compared to delaying grazing to May 31.

5) Manage grazing pressure to assure that livestock meet their nutritional requirements and that pasture is not overgrazed. This may require harvesting surplus pasture, removal of surplus animals, or supplemental feeding on pasture.

6) Use some form of rotational grazing to ensure that pasture species have an adequate recovery period. Grazing pastures too closely throughout the season reduces capacity for photosynthesis and lovers pasture production.

7) Within practical limits, pasture should not be alloved to mature. While this represents a reserve for late season grazing, such stands decrease in yield and quality, suffer a high loss due to trampling and fouling when finally grazed, and will not respond to late season precipitation nearly as well as a stand that has been kept from maturing*.

8) Check pastures (especially native pastures) for poisonous plants and plan grazing at times to reduce the possibility of poisoning. Most poisonous weeds have stages during which they are particularly toxic. In general, poisonous plants are not consumed if the productivity of the pasture is good.

9) Use fertilizer where there is a possibility of an economical response, i.e. a good plant population, adequate moisture, amenable topography. Use soil tests and average herbage yield and composition data to determine optimal rate and kind of fertilizer to apply. Because of widely varying conditions, producers are encouraged to determine responses to fertilizer on their own pastures by using small, protected check strips.

10) If feasible, consider practices for the control of weeds and unvanted brush and other woody species. Controlled burning, heavy duty rotary mowing, use of herbicides, seeding and harvesting annual crops for a year or two, have all been used with varying degrees of success in improving pasture production. Remember that trees and bush trap snow, protect land and cattle from the wind, provide cattle with shade and some protection from insect attacks and have other ecological benefits. Thus, a reasonable proportion of the pasture area should be left in trees and bush.

11) Control insect pests on pasture through the use of approved insecticides in oilers, back rubbers and ear tags.

---

*It is preferable to include some leafy species (e.g. Russian wildrye, meadow bromegrass, Rebound smooth bromegrass, cicer milkvetch) in the pasture program for late grazing, rather than attempt to 'stockpile' species which produce most of their growth in the early part of the grazing season.

12) Terminate the grazing season in time to leave enough plant material to trap snow which will improve the moisture supply for next year's growth and provide some protection from very cold soil temperatures.

WATER SUPPLY

Be sure water quality and quantity are adequate. Water should contain less than 100 p.p.m. nitrates and less than 7000 p.p.m. of total salts. Water requirements vary with weather conditions and the kind, amount, and water content of feeds consumed. As a rough guide, beef cows should have about 55 l (12 gallons) daily and growing beef cattle [365 kg (800 lb.)] about 35 l (8 gallons). When assessing overall seasonal requirements on pasture, allow for losses due to seepage and evaporation. Use of large water tanks on pasture, vs water bowls, may be preferable if pumping systems are prone to periodic failure. When dugouts become polluted with algae, the addition of 454 g (7 lb.) of copper sulfate for each 454 kilo litres (100,000 gallons) every few weeks as required, will be effective. (Note: while this treatment has been recommended and used for years, it has recently been determined that it was not officially approved by regulatory agencies of the government.)

FENCING

Because pastures are often located some distance from the farm headquarters, real problems can arise before "escaped" cattle can be discovered. It is thus very important that well built fences be constructed at least around the perimeter of the pasture operation. The increasing popularity and economic advantages of multi-field rotational grazing does increase the need for considerably more fencing. Careful planning of "internal" fencing is important, if the length and cost of fencing is to be minimized, consistent with optimal use of pastures.

Prime considerations involve the following:

- optimum (practical) number of fields that can be managed under rotational grazing,

- number and size of distinctly different soil types in the area involved,

- number of different forage species required to optimize production from each soil type and/or to provide the mix of separately grazed species best able to extend the growing season,

- source of water supply, is it less costly to design the fencing system to allow all cattle access to a common watering station, or will it pay to develop several watering sites by constructing dugouts, laying underground pipelines, etc.,

- protection of waterways from pollution,

- protection of treed areas serving both as windbreaks and shade for cattle,

- need to facilitate movement of cattle, from field to field and to a central handling facility.

Having considered the foregoing factors, are there any options for minimizing the amount of cross-fencing required? While a round area contains more land per unit of fence than any other configuration, it is usually impractical for several obvious reasons. The most efficient alternative is a square, with decreasing area/unit of fence as the rectangle becomes narrower in relation to its width. This is illustrated in Figure 13.

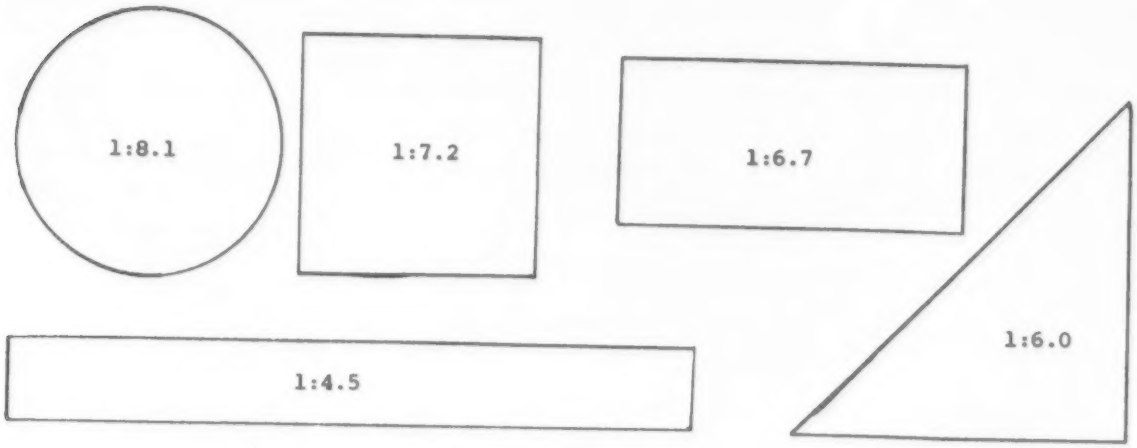


Fig. 13. Efficiency of fencing areas of different shapes (unit of length:unit of area)

Ratio indicates units (length) of fencing per unit of area contained.

Remember also that internal fencing confines cattle on both sides of the fence. In many instances internal fencing will likely be curved to conform with natural boundaries of differing soil types, however, some minor deviations from this may be justified on the basis of facilitating land operations or in simplifying fence construction (bracing, etc.). Some time spent on devising efficient fencing plans can pay big dividends.

For information on types of fencing, please refer to "The Beef Cow-Calf Manual", Alberta Agriculture Agdex No. 420/10 or contact the Prairie Agricultural Machinery Institute, Box 1900, Humboldt, Saskatchewan, S0K 2A0.

SUGGESTED MODEL FOR A PASTURE OPERATION ON A SECTION OF PRODUCTIVE SOIL

FIELD LAYOUT (Fig. 14)

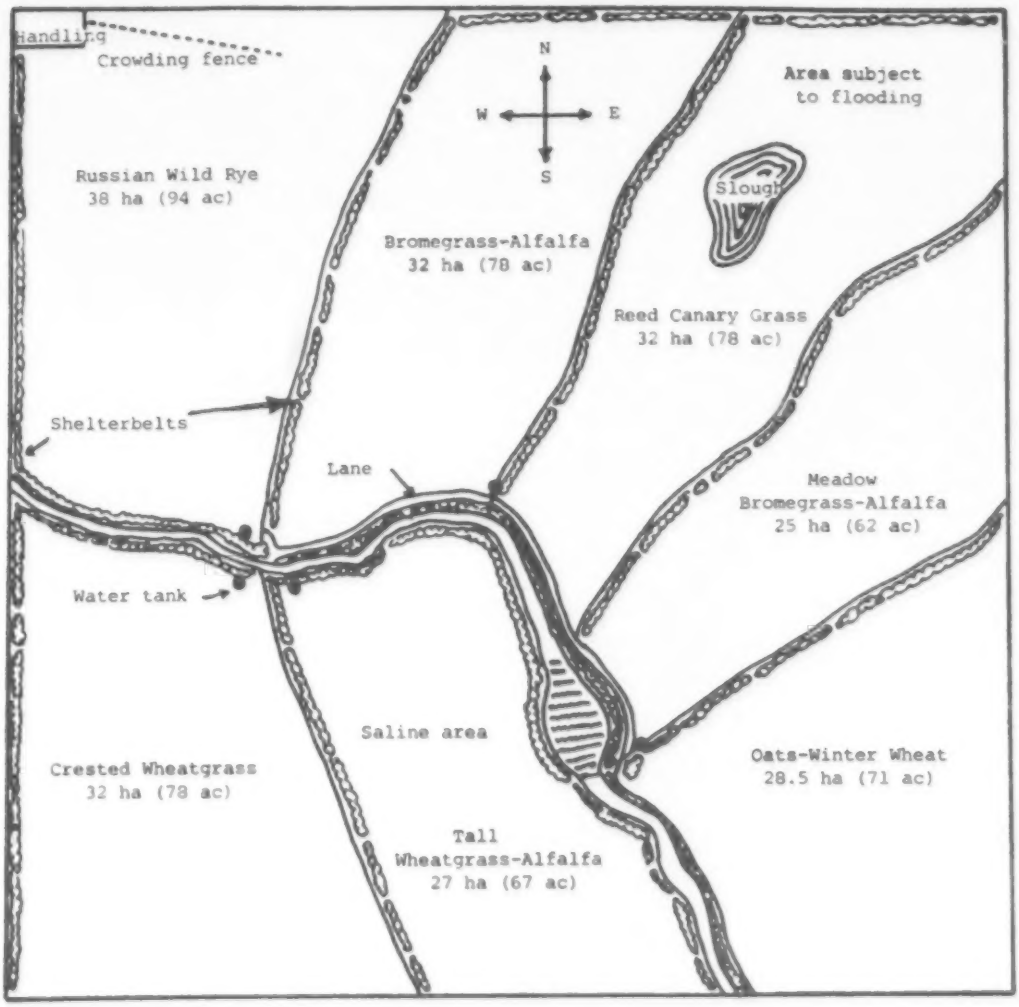


Fig. 14. Model one-section pasture layout.

FEATURES

1. The section on black, silty clay loam, is crossed by a creek, dammed at one location to provide a reliable supply of water for cattle and for limited irrigation, if needed.

2. There is a 32 ha (78 ac.) area containing a slough and subject to spring flooding, and a 27 ha (67 ac.) area that is affected by salinity. The remaining area is well-drained. All areas are amenable to cultivation. [Total 213 ha (528 ac.) cultivated.]

3. There are extensive shelterbelts to trap snow and to provide shade to livestock. These shelterbelts are protected from the cattle by permanent or electric fencing.

4. All fields are adjacent to the creek. Cattle could have direct access to the creek, but preferably the creek could be protected from pollution by fences, And watering bowls/troughs installed nearby [float-controlled individually (solar!) powered units].

5. A basic seven field rotation with provision to sub-divide individual fields with electric fences, if required for better control of grazing. Seven different forage species are included, tailored to soil type or condition, including one field in oats, which would be underseeded with winter wheat or fall rye or with the appropriate perennial species when a depleted stand required replacing. Annuals could be harvested as silage if not grazed.

6. All fields (except #7) have direct access to a perimeter road to facilitate field operations (cultivating, seeding, fertilizing, weed/brush control, and haying).

7. Gates placed in corners of field to facilitate rotation of cattle from field to field, with a short alleyway connecting all fields if "leap-frogging" of fields is necessary.

8. Forage species selected to provide a wide range of growth patterns over a long grazing season (assumed maximum 140 days under parkbelt conditions).

9. Handling facilities in N.W. corner of field #1 with crowding fence to facilitate funneling cattle into corral.

SUGGESTED SEASONAL PATTERN OF USE

Figure 15 indicates the expected period during which the various forage species could be grazed given normal growing conditions in the Aspen parkbelt. Within this time frame grazing of any one species should be scheduled to allow reasonable rest and recovery periods which will vary between species and which will depend on growing conditions. This is particularly important for a species such as Russian wild rye which is counted on for both early and late grazing. It is important that a reasonable "stubble" be left on pasture to catch and hold snow. This will not only improve amount and uniformity of moisture supply for early spring growth, but provide insulation to the wintering forage plants which may be

critical to survival if root reserves are lov and/or winter temperatures are colder than normal over a sustained period of time.

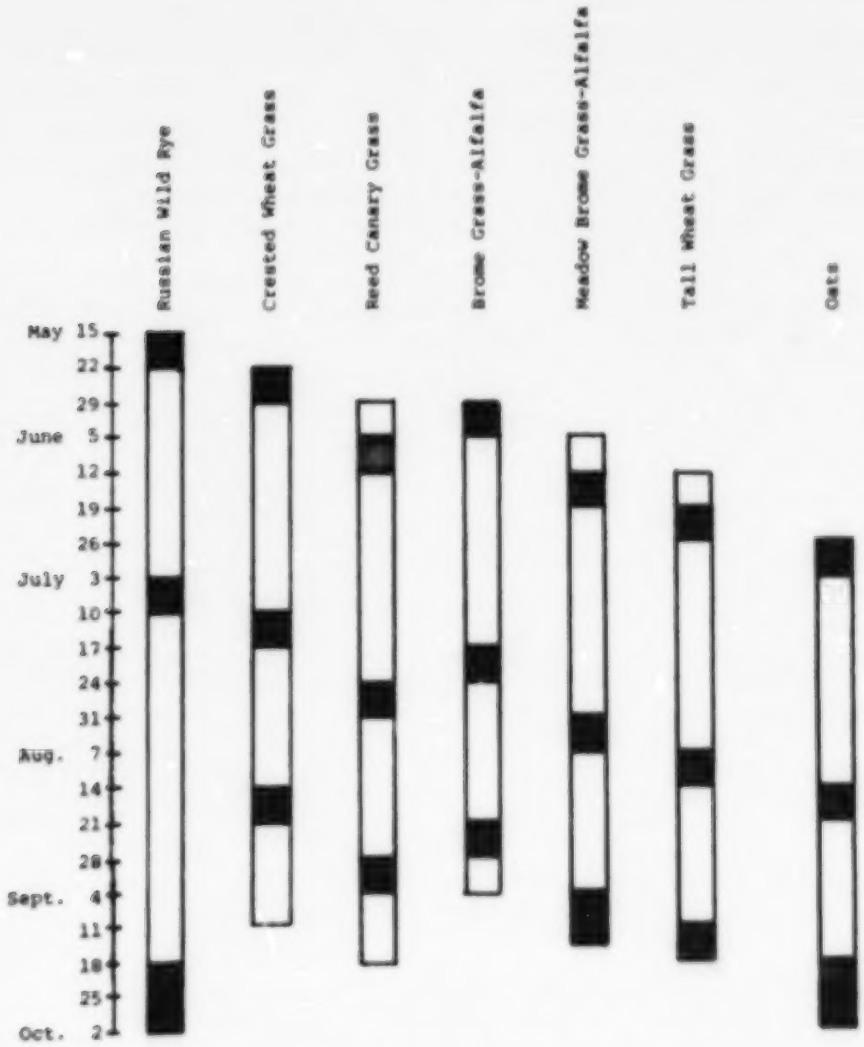


Fig. 15. Example seasonal pattern of pasture use.

Certain forage species are best grazed within specified minimum and maximum heights for optimum use. Suggested heights for species included in this model are as follows:

Species	Begin grazing	Keep height within	Leave as stubble in fall
Russian wild rye	10-13 cm (4-5")	no limit	5 cm (2") min.
Crested wheatgrass	13 cm (5")	don't allow to go to head	8-10 cm (3-4")
Reed canarygrass	15 cm (6")	10-30 cm (4-12")	10-15 cm (4-6")
Brome-alfalfa	13-15 cm (5-6")	graze before fully headed	12-14 cm (4-5")
Meadow bromegrass	25 cm (10")	above 8-10 cm to fully headed	15 cm (6")
Tall wheatgrass	13 cm (5")	7 cm (3") to fully headed	15 cm (6")
Oats	25 cm (10")	7-10 cm (3-4") to heading	7-10 cm (3-4")

Comments

1. This scenario assumes that moving the herd at weekly intervals will be able to utilize the overall pasture production effectively. In practice, the pasture manager must continually assess the situation. If pastures are getting ahead of the grazing animals it will mean that some should be harvested for hay or silage or that the grazing "plan" is altered in order to graze the faster maturing species earlier in an effort to keep them from maturing to the point that they lose palatability and their potential for recovery.

2. If the grazing animals are consuming the pasturage too quickly, there are several actions that can be taken. One is to reduce the number of animals. Surplus feeder cattle can be moved into the feedlot for finishing or sold as feeders, although the latter option is seldom profitable. Surplus cow-calf units will have to be removed to supplementary pasture. The wise cattleman will have available an emergency pasture of oats, spring seeded winter wheat or fall rye.

The other option is to provide supplementary feed or pasture in the form of hay, silage, soilage and/or grain. A wise livestock producer carries a years supply of feed in reserve.

Irrigation of some pasture land is another alternative that may be available to a few pasture managers.

3. In some situations, the grazing pressure can be balanced to the

pasture available by placing feeder cattle (last year's calves) with, (or following) the cow-calf herd during the early part of the grazing season (first 5 to 6 weeks) and then removing them to the feedlot for finishing. Similarly, calves can be weaned prior to the end of the grazing season and either placed on special fall pastures or placed on dry feed in the feedlot. This keeps the calves gaining weight and reduces the pressure on both the cow and the summer pasture, this helping the cow to gain some weight prior to going onto the winter feeding program.

A. ESTIMATED PRODUCTIVITY OF THE PASTURE ENTERPRISE USING GRAZING STEERS

ASSUMPTIONS

1. Average dry matter production

RVR	38 kg (94 ac)	4275 kg/ha (3800 lb/ac)
CWG	32 ha (78 ac)	4500 kg/ha (4000 lb/ac)
RCG	32 ha (78 ac)	5625 kg/ha (5000 lb/ac)
Br-Alf	32 ha (78 ac)	5062 kg/ha (4500 lb/ac)
MB-Alf	25 ha (62 ac)	5062 kg/ha (4500 lb/ac)
TW-Alf	27 ha (67 ac)	5400 kg/ha (4800 lb/ac)
Oats	28.5 ha (71 ac)	5625 kg/ha (5000 lb/ac)

2. Feed:gain ratio - overall average 10 (DM)

- Assuming good grazing management, i.e. grazing pasture at optimum feeding value; use of growth promoting implants, fly control, provision of shade, water, salt and mineral mix.

- Assuming cattle placed on pasture in good gaining condition (i.e. lean and healthy.

- Assuming use of crossbred, exotic-sired cattle.

- Assuming all pastures fertilized - 90 kg N, 45 kg P_2O_5/ha (80 lb. N, 40 lb. P_2O_5/ac.).

- Assuming some benefit from the shelterbelts
  - trap more snow, reduce evaporation
  - provide cattle with cool, shady areas on hot days.

3. A total grazing period of 140 days (May 15 - October 2)

4. Steers:

- Weight on 295 kg (650 lb.), weight off 454.5 kg (1000 lb.), average daily gain 1.14 kg (2.5 lb.).

- Requires 6.25 kg (13.75 lb.) TDN/hd/day.

- Pasture DM 55% TDN requires 11.4 kg (25 lb. DM) steer/day or 1591 kg (3500 lb.) DM per season/steer.

- Total pasture dry matter: 1,075,364 kg (2,365,800 lb.), 90% consumed = 967,827 kg (2,129,200 lb.)

- Therefore number of steers = 967,827 ÷ 1591 = 608 head.

- Assuming a 1.3% death loss would mean that 600 head could be marketed off pasture.

- Estimated Gross Income: Sell 600 head @ 454.5 kg (1000 lb.) @ 1.87/kg (85¢/lb.) = $510,000

- Estimated Costs

Buy 607 hd @ 295.5 kg (650 lb.) @ $2.20/kg ($1.00/lb.)	$ 394,550.00
Trucking to and from market plant @ $15	9,000.00
Veterinarian (vaccinations, etc.) @ $5	3,035.00
Implant @ $1.75	1,062.25
Salt (0.5% of forage DM) 4838 kg (10642.5 lb.) @ 30.8¢/kg (14¢/lb.)	1,490.02
Mineral (0.5% DM) 4837.5 kg (10642.5 lb.) @ 70.4¢/kg (32¢/lb.)	3,405.60
Fertilizer	
N = 90 x 213.2 ha (80 x 528 ac) x 51.7¢/kg (23.5¢/lb.)	9,926.40
P_2O_5 = 45 x 213.3 ha (40 x 528 ac) x $1.28/kg (58¢/lb.)	2,249.60
Interest @ 10% on investment (cattle)	15,133.42
Miscellaneous	
Upkeep of facilities, $49.50/kg ($20/ac.)	12,800.00
Estimated total operating cost	$ 462,652.29
Estimated return to labor & investment	$ 47,347.71
	or $183/ha ($74/ac.)

Note: In this example it would likely be necessary (or advisable) to place the steers in a feedlot for finishing, since exotic cattle will not likely be even close to finish coming off pasture at 454.4 kg (1000 lb.). If we make the following assumptions (based on an actual feeding trial) the economics of finishing the steers can be estimated as follows.

Assumptions	
Av. initial weight	454.5 kg (1000 lb.)
Days on feed	80
Av. daily gain	1.59 kg (3.50 lb.)
Av. final weight	582 kg (1280 lb.)
Feed:gain ratio	8.50

Consumption/head				
Ground hay	605.50	@ 6.6¢	(1332 lb. @ 3¢)	$ 39.96
Rolled barley	385.00	@ 11¢	(843 lb. @ 5¢)	42.35
Ground straw	43.20	@ 3.3¢	(95 lb. @ 1.5¢)	1.43
Acid. fatty acids	31.80	@ 33¢	(70 lb. @ 15¢)	10.50
Co. I. TM salt	8.20	@ 30.8¢	(18 lb. @ 14¢)	2.52
Calcium phosphate	5.45	@ 70.4¢	(12 lb. @ 32¢)	3.84
Limestone	2.34	@ 12.1¢	(5.15 lb. @ 5.5¢)	0.28
Dry ADE	0.113	@ 127.6¢	(0.25 lb. @ 58¢)	0.15
Aurofac 50	0.27	@ $5.39	(0.60 lb. @ $2.45)	1.47
Total	1081.8 kg		2380 lb.	$ 102.25

COMBINED PASTURE & FINISHING ENTERPRISE

Estimated gross income:
600 x 581.8 kg (1280 lb.) x $1.87/kg (85¢/lb.) $ 652,779.60

Estimated costs:

1.	Purchase of cattle	$ 394,550.00
2.	Trucking to farm & to plant, 607 @ $5	3,035.00
	600 @ $15	9,000.00
3.	Veterinary expense @ $5	3,035.00
4.	Implants (2) @ $1.75	2,124.50
5.	Pasture minerals + salt	4,895.62
6.	Pasture fertilizer	22,176.00
7.	Feedlot feed @ $102.25	61,350.00
8.	Feedlot yardage @ 15¢/day	7,200.00
9.	Interest @ 10% (220 days)	23,781.10
10.	Pasture facility upkeep @ $49.50/ha ($20/ac)	12,800.00
11.	Death loss 1% of total costs	5,439.47
	Total operating costs	$ 549.386.69
	Est. return to labor, land & equipment	$ 103,413.31
	or $355.48/ha ($161.58/ac)	

Under the economic situation assumed, it would be decidedly worthwhile to finish the steers in the feedlot following the pasture season.

B. ESTIMATED PRODUCTIVITY RETURNS UNDER A COW-CALF ENTERPRISE

ASSUMPTIONS

1. Total dry matter production, 1,075,363.6 kg (2,365,800 lb.) - 90% consumed, 967,827.4 kg (2,129,220 lb.)

2. Average weight of cow, 545.5 kg (1200 lb.), weight of calves on pasture 150 kg (330 lb.) (average weight over pasture season).

3. TDN requirements:
   - for cows: 5.60 kg (12.3 lb.)
   - for calf: 2.14 kg (4.7 lb.)
   Total 7.74 kg (17.0 lb.)

If TDN of pasture = 55%, it would require 14.1 kg (31 lb.) DM/cow calf unit/day.

4. Length of grazing period, 140 days. Total pasture DM/cow-calf unit/season, 1973 kg (4340 lb.).
Therefore: 967,827 ÷ 1973 (2,129,220 ÷ 4340) = 490 cow-calf units.

5. Assuming cows will maintain their weight (or better) and be a cost borne by the calves.

6. Assuming calves gain 1.14 kg (2.5 lb.) daily over a 140 day period = ending weight 280 kg (615 lb.) (av. for steers & heifers).

7. The pasture enterprise covers the cow and calf for the 140 day period only, and that its productivity involves two criteria: the maintenance of the cow and the gain of the calves.

Estimated increase in value of the calves (assuming 98% survival on pasture):

Value of calves on 490 x 120.5 x $2.64/kg (265 x $1.20/lb.)	$ 155,820.00
Value of calves off 486 x 279.5 x $2.09/kg	283,945.50
Difference	$ 128,125.50

COSTS ON PASTURE

1.	Trucking to & from pasture, $10/cow-calf unit	$ 4,900.00
2.	Veterinary @ $5	2,450.00
3.	Implant (Synovex C) @ $1.75	857.50
4.	Salt	1,490.02
5.	Mineral	3,405.60
6.	Fertilizer (N & P)	22,176.00
7.	Misc., pasture fencing, water system, fly control etc. @ $49.50/ha ($20/ac.)	12,800.00
8.	Interest on the cows, $800 x 490 x 10% (140 days)	15,035.62
	Total Operating Cost	$ 63,144.74
	Return to labor & investment, land	$ 65,010.76
	or $251.41/ha ($101.58/ac)	